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SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

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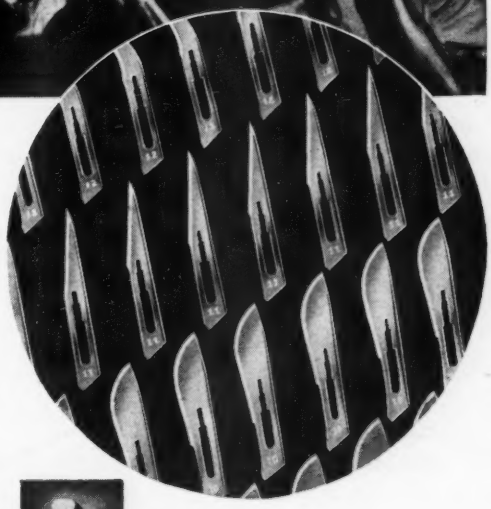

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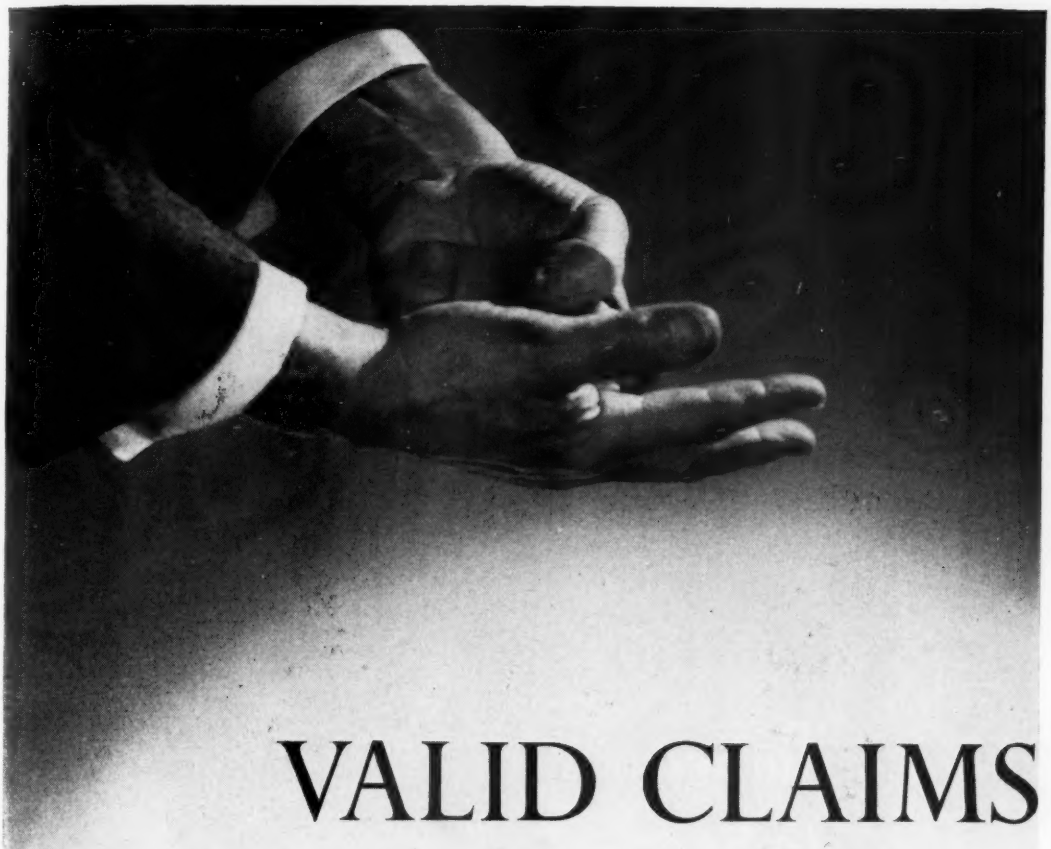

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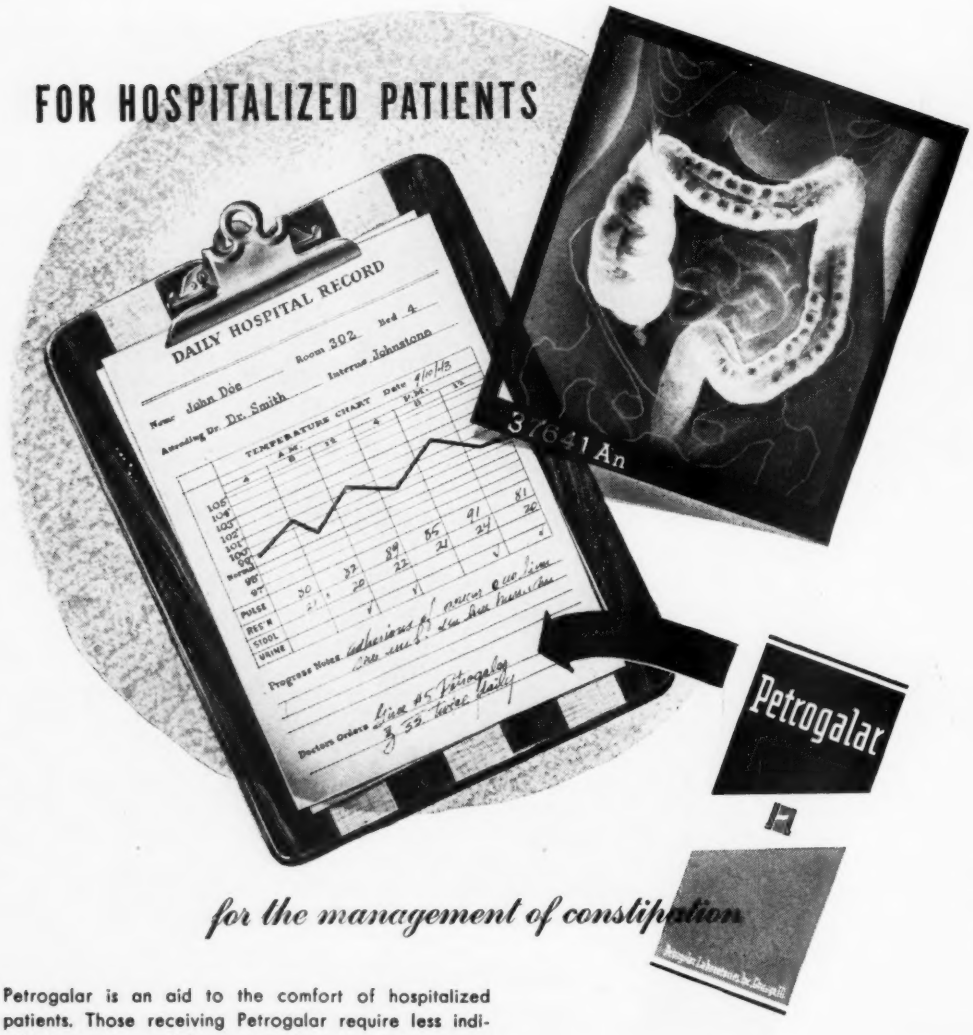

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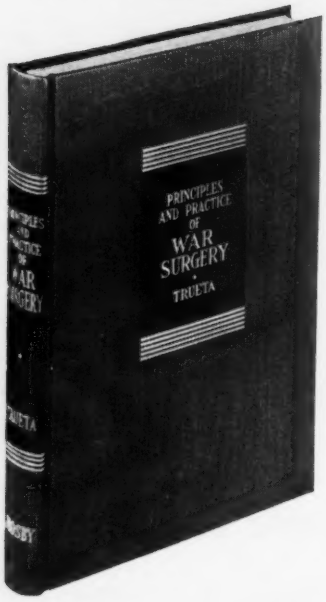

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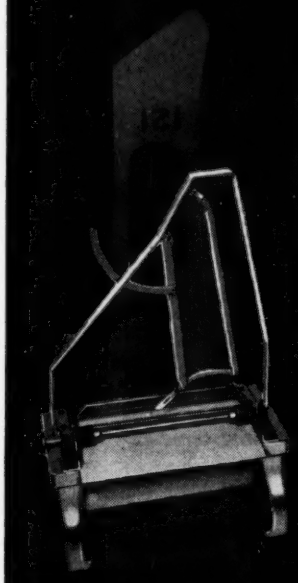

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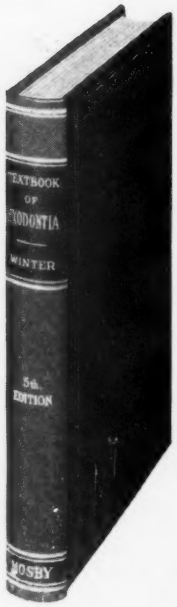

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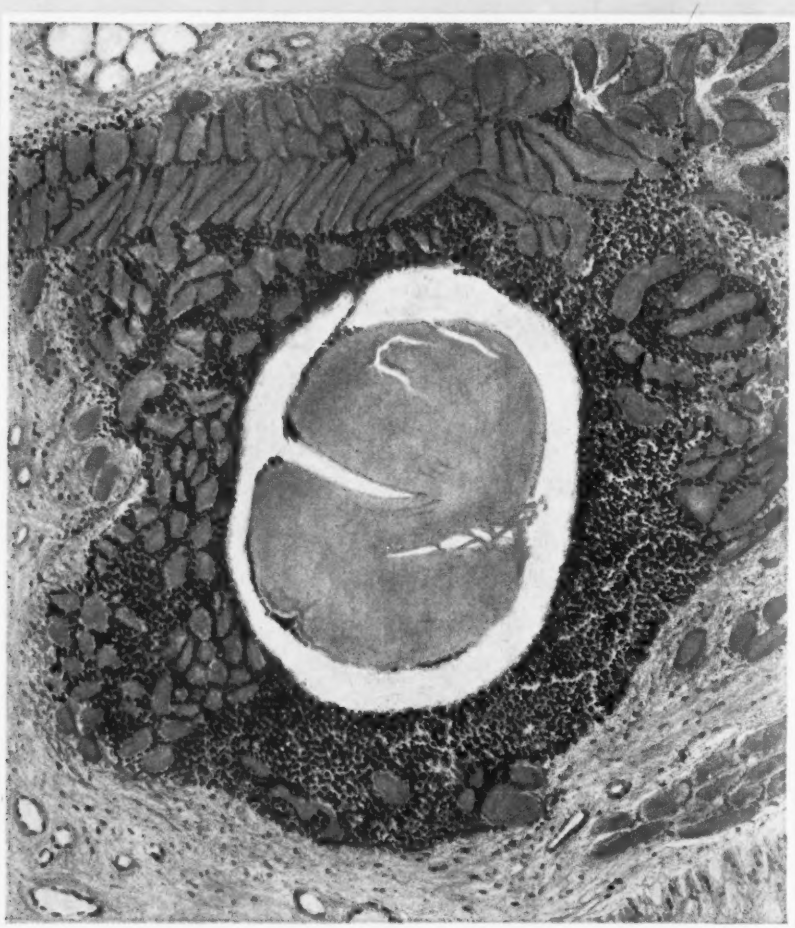

1. Composite section showing Size 2 Medium Chromic Surgical Gut imbedded in abdominal wall of a rabbit. Tissue was excised on seventh postoperative day. (Hematoxylin and Eosin stain.) Magnification of drawing, x50. Note extensive leukocytic infiltration and inflammatory exudate. Clear zone surrounding surgical gut is due to fixation shrinkage.

2. Composite section (x50) showing Size 00 Medium Chromic Surgical Gut imbedded in abdominal wall of rabbit, and removed on seventh day. Note minimal leukocytic infiltration and absence of inflammatory exudate in marked contrast to extensive reaction with larger suture. Clear zone surrounding surgical gut is artifact due to fixation shrinkage.

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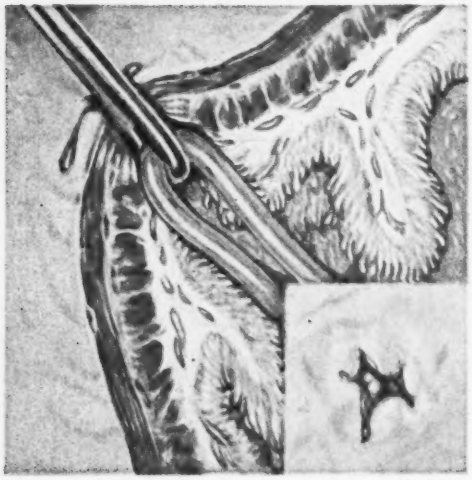

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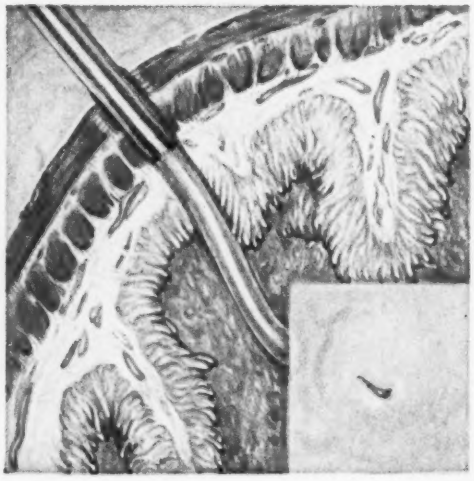

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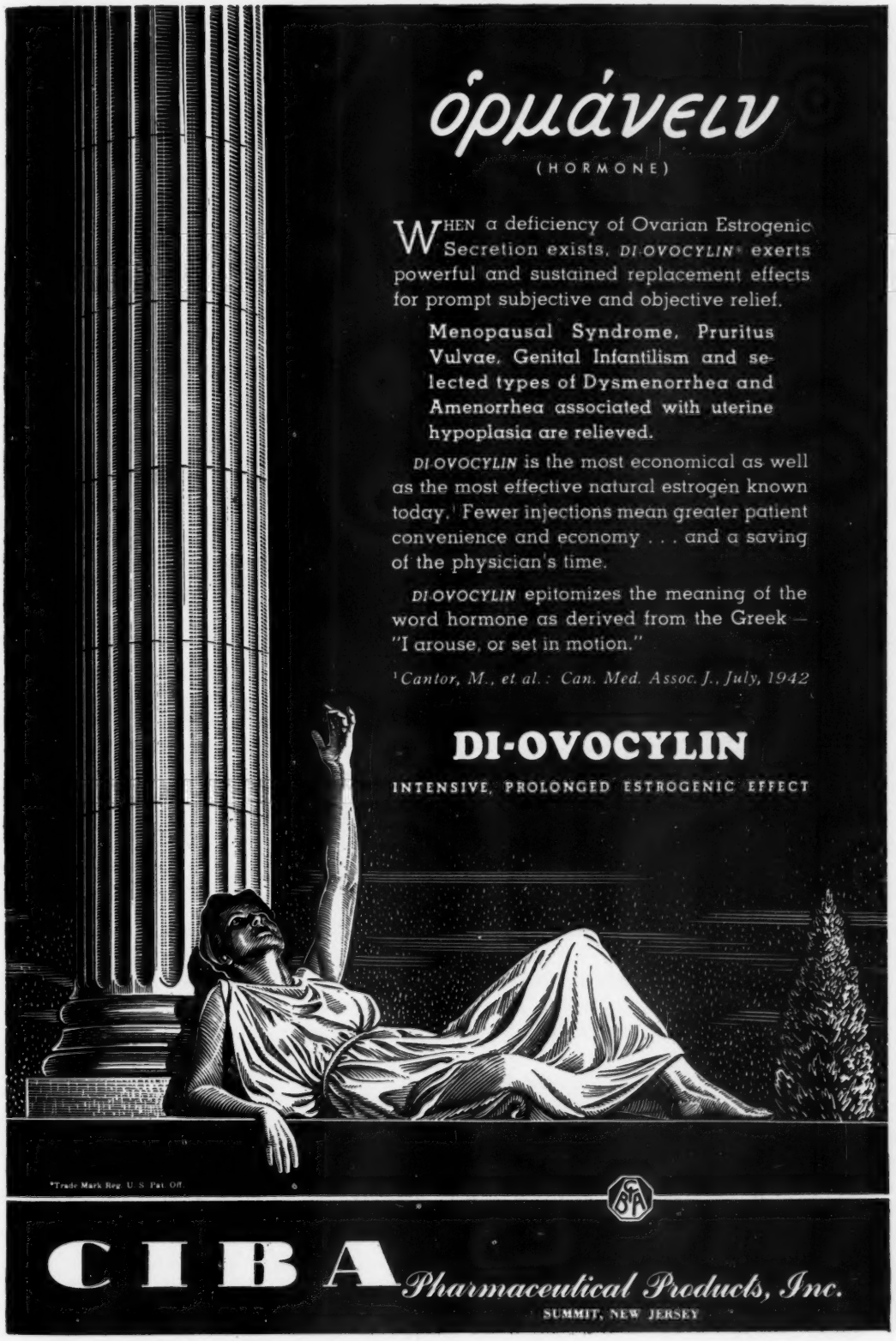

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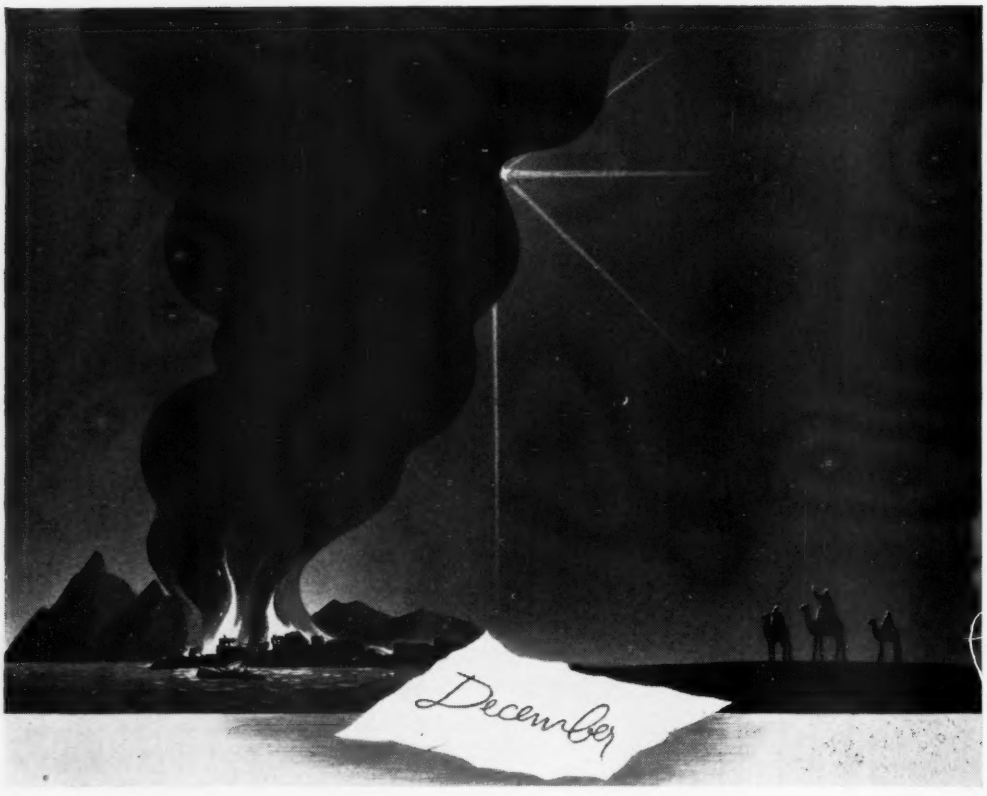

DECEMBER... the star of Bethlehem and the bombs of Pearl Harbor... the Prince of Peace and the god of war ☆ Christmas will have little meaning to the thousands of physicians who serve their country and perhaps to thousands more who strive to carry on at home. There is little time for exchange of pleasantries in the grim business of winning a war ☆ But the Christmas Season will come again when the forces of evil are dead — when man again will do unto others as he would have done unto him.

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THE SURGICAL TREATMENT OF RECURRENT INGUINAL HERNIA WITH SPECIAL REFERENCE TO A COOPER'S LIGAMENT HERNIOTOMY AND THE USE OF FREE FASCIAL GRAFTS

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UNTIL late in the nineteenth century, the recurrence of a previously surgically repaired hernia was not an unexpected result. At that time, recurrence rates were quoted as high as 25 to 50 per cent of all cases in which operation was done.

Although present-day recurrence rates are much lower, most often being quoted from 5 to 15 per cent, it is evident that the operation for primary inguinal hernia may be found wanting in many instances. Recently, one of us (H.N.H.) reported a series of 131 consecutive cases in which the McVay modification of the original Lotheissen technique was used, with only one recurrence after a relatively short follow-up period. This technique involves the suture of the transversalis fascia and conjoined tendon to Cooper's ligament rather than to Poupart's ligament. Nothing is fastened to Poupart's ligament. Hence, the operation is properly designated as a Cooper's ligament herniotomy. This communication deals with the results of operation in 37 consecutive cases of recurrent hernia, done during the past two years (1940 to 1942) on the service of one of us (H.N.H.) on 34 patients, with no recurrences to date. Thirty-four of the operations were performed by the senior author, one by the other of us (S.A.S., Jr.), and two by another resident.

In his book, Iason (1941) bases success or failure in operations for hernia upon:

a. The technical method utilized.
b. Failures in technique, hematoma formation, slipping ligatures, etc.
c. Postoperative pulmonary complication, i.e., cough, hiccough.

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d. Double hernia operations.
e. Constitutional factors.
f. Hereditary tendencies to hernia or congenital atony of the abdominal musculature or changes in the fasciae.
g. Age.
h. Sex.
i. Obesity.
j. The type of work the patient engages in postoperatively.
k. Transplantation of the spermatic cord.

It is difficult to draw the line too sharply as to what may be classed as a recurrent hernia. True recurrences, i.e., the appearance of the hernial sac in the same position as that of the previous operation, are usually the result of failure to ligate the sac at all or failure to ligate it high enough. It is rare, and almost impossible, after an adequate high ligation, for a hernial sac to return at the original site of protrusion. When this does occur, however, there is usually some contributory anatomic muscular or fascial defect surrounding the hernial opening.

False recurrences, or the appearance of a sac in a position different from that observed in the primary operation, are most common. The etiology of this condition may be based upon any one or more of the factors listed by Iason. In our series, as well as the series reported by Fallis in 1937, the number of direct recurrences resulting from operations on indirect hernias done in the Henry Ford Hospital seems to indicate that in this institution the factors which tend to prevent the appearance of a direct hernia were being neglected. At the time of Fallis' report, 88.6 per cent of the hernial repairs were done without transplantation of the cord. Since that time, however, transplantation of the cord has been done on a greater number of patients with the satisfactory result of fewer direct recurrences. At the present time the following rule seems to hold true for hernias operated upon for recurrence at the Henry Ford Hospital. Those patients whose primary operation was performed elsewhere have indirect recurrences; those whose primary operation was performed at our own hospital have direct recurrences. This rule, proposed by Dr. Fallis, seldom fails. Its rationale is that the hernias done elsewhere demonstrate that the sac was either not ligated at all, or ligated too low (in one case operated upon in Europe over 30 years ago, there seemed to be no evidence that the external oblique aponeurosis had ever been opened, a tuck merely having been taken in the external ring); while in our own operations done previous to 1937, there is adequate high ligation of the sac, but often incomplete buttressing of Hesselbach's triangle. In their review of experiences with the McVay herniotomy, Harkins and his co-workers demonstrated that with this type of repair Hesselbach's triangle was adequately reinforced, and in the one recurrence cited the sac was found at the internal ring. No direct recurrences following the McVay procedure, using either the original Halsted or the Bassini closure, have

been observed over a period of three years. From these observations, one might correctly assume that even though the McVay procedure was originally designed as a repair of large direct hernias, it is equally applicable in indirect hernias, as it so adequately reinforces Hesselbach's triangle and greatly reduces the possibility of a direct recurrence.

Many authors agree that if inguinal hernias do recur, they do so within one month following operation. Iason (1941) states that there is always some evidence of recurrence even before the patient leaves the hospital, and within a few weeks a definite hernia is revealed. In Fallis' series (1937) of 200 recurrent hernias, 82 or 41 per cent were first noted within six months from the original operation.

In the review of this series of cases, it is interesting to note that until the senior surgeon (H.N.H.) became familiar with the McVay procedure, free fascial grafts were used in most of the cases of recurrent inguinal hernias. In general, all of the 37 recurrent hernia operations were done by two methods: (1) fascial graft, and (2) Cooper's ligament procedure (McVay-Lotheissen) using silk. Fascia was used ten times in the first twelve hernial operations, but more recently this suture has been almost entirely abandoned so that fascia was used only two times in the last twenty-five recurrent hernial operations. The technique used was essentially that as proposed by Gallie and LeMesurier (1921). One or two strips of fascia lata 20 to 30 cm. in length were obtained from the thigh by the Wilson fascial stripper, and were used as suture material, usually joining the transversalis fascia and conjoined tendon to Poupart's ligament, and occasionally, a second row of fascial sutures would be placed, including the medial flap of the cut oblique aponeurosis fascia. Alterations in the technique were based upon the use of either the original Halsted or Bassini type of closure.

During the past two years, the McVay technique has been used by us more and more extensively in the repair of recurrent inguinal hernia. With adequate dissection of the structures involved it is usually possible to close off entirely Hesselbach's triangle and suture the conjoined tendon and the transversalis fascia to Cooper's ligament. As has been stated in a previous article, it is absolutely necessary that the sutures be placed without tension and this procedure is greatly facilitated by a relaxing incision in the internal oblique aponeurosis made near the midline at its junction with the anterior rectus sheath. This relaxing incision is extended from about 2 cm. above the pubic symphysis superiorly for a distance of 8 to 10 cm. With sufficient relaxation the transversalis fascia and conjoined tendon are sutured to Cooper's ligament with double heavy silk sutures. The femoral vessels are held out of the way with the index finger placed upon Cooper's ligament, and the most lateral suture is placed first, the vessels being guarded by the finger. The double sutures are first knotted together and then tied separately, effecting a braiding of the suture. Two or three more such

sutures are placed on down to the pubic tubercle, the last being taken in Gimbernat's ligament and resulting in complete closure of Hesselbach's triangle.

ANALYSIS OF CASES

Sex.—All of the 34 patients operated upon for recurrent inguinal hernia in this series were men. In a series of 200 operations, Fallis (1937) reported a percentage of 1.5, or 3 women in the entire series.

Age.—Seventy-eight per cent of the cases of recurrent inguinal hernia were in patients in the fourth and fifth decades of life. This figure exactly equals that of Fallis (1937), while Wilmoth (1937) found that in his series of 164 cases of recurrent inguinal hernia, 53 per cent were beyond the age of 40. This suggests that the general laxness of the abdominal wall structures seen at this age may be directly responsible for the frequently weakened internal oblique muscle.

TABLE I

AGE INCIDENCE IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

AGES	NO. OF CASES	PERCENTAGE
15-19	1	2.7
20-24	2	5.4
25-29	1	2.7
30-34	1	2.7
35-39	2	5.4
40-44	9	24.3
45-49	8	21.7
50-54	9	24.3
55-59	3	8.1
60-64	1	2.7
Total	37	100.0

Occupation.—Although most of the reports of recurrent inguinal hernia show a major percentage of patients doing hard labor, the figure of 89.2 per cent in our series may be somewhat high, as most of our patients are engaged in heavy industrial work.

TABLE II

OCCUPATION OF PATIENTS IN SERIES OF THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

OCCUPATION	NO. OF CASES	PERCENTAGE
Hard Labor	33	89.2
Sedentary	4	10.8
Total	37	100.0

Duration of Original Hernia.—Six, or 16.2 per cent, of the 37 patients presented themselves for operation within one year after noticing a hernia present, while 3, or 8.1 per cent, did not avail themselves of repair until their hernia had been present for more than ten years. In

20 of these cases, it was impossible to determine the duration of the original hernia, the usual reply to the question being: "For quite some time, but I can't say just how long."

TABLE III

DURATION OF ORIGINAL HERNIA IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

DURATION	NO. OF CASES	PERCENTAGE
Less than 1 yr.	6	16.2
1 yr.	3	8.1
5 yr.	3	8.1
10 yr.	2	5.4
More than 10 yr.	3	8.1
Not known	20	54.1
Total	37	100.0

Original Hernial Type.—Again, it was difficult to determine the hernial type at the original operation when the operation was done at some place other than Henry Ford Hospital. Occasionally the records of other hospitals could be checked, but in 12, or 32.4 per cent, of our cases the original type was not known. At the time of the second operation, it was sometimes possible to determine the type of the original hernia from the position of the sac or the type of the original repair. It is interesting to note that in the 25 cases we were able to check, no saddlebag or femoral hernias were present at the time of the original operation, but that at second operation, two direct-indirect hernias and one femoral hernia were found.

TABLE IV

ORIGINAL HERNIAL TYPE IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

TYPE	NO. OF CASES	PERCENTAGE
Indirect	19	51.4
Direct	6	16.2
Not known	12	32.4
Total	37	100.0

Hospital of First Operation.—Ten of the 37 patients were originally operated upon at Henry Ford Hospital and it is interesting to note that only 3 of these cases presented indirect recurrences, 1 of these being the only case of a recurrence from a McVay herniotomy done in this institution.

Type of First Operation.—One of the most interesting factors in the operation for recurrent inguinal hernia is the opportunity to note the technique used in the first attempt to repair the defect. It is at this time that the student of anatomy may observe firsthand the inadequacies of some types of repair, and may learn the true cause for the failure presented to him. Tissue reactions to suture material have proved extremely interesting. In all cases where absorbable sutures had

been used, the scarring was so extensive that it was difficult to recognize and dissect free the essential structures for an adequate repair, while in those cases in which silk had been used, scarring was minimal and the fascial layers were easily discernible, greatly facilitating the repair of the defect. Fifteen, or 40.6 per cent, of the cases had had a Bassini repair at the first operation, retaining the cord beneath the external oblique aponeurosis, while 9 or 24.3 per cent, had had the cord transplanted beneath the skin in the manner of the original Halsted operation. In making the incision for operation of recurrent inguinal hernia, great care must be taken until the cord structures are recognized. If the incision is made without regard to underlying structures, a subcutaneous cord may be easily transected before it is recognized.

In two cases, the only evidence of previous operation was the skin incision and a scarring around the external ring as though several sutures had been placed in the loose areolar tissue producing a tucking effect and narrowing of the external ring. The aponeurosis of the external oblique and the cord had been left in position undisturbed. One of these patients had had his first operation done in Europe thirty years previously. The other one had been operated upon in the United States.

TABLE V

TYPE OF FIRST OPERATION IN THIRTY-SEVEN CASES OF RECURRENT INGUINAL HERNIA

TYPE OF OPERATION	NO. OF CASES	PERCENTAGE
Bassini	15	40.6
Original Halsted	9	24.3
Modified Bassini	2	5.4
Ligation of sac only	1	2.7
Closure of external ring	2	5.4
Ferguson	2	5.4
Halsted I-McVay	1	2.7
Not known	5	13.5
Total	37	100.0

Suture Material in First Operation.—Silk sutures were found in 9 cases, or 24.4 per cent, of the series. As was previously stated, in those cases in which silk had been used as a suture material, identification of fascial structures was much less difficult than in those cases in which absorbable sutures had been used. Most of the cases in which absorbable sutures had been used in the first operation showed evidence of severe tissue reaction with extensive scarring. Silk sutures have been used exclusively in all hernial repairs in the Henry Ford Hospital for more than five years, and in the series of McVay herniotomies reported by Harkins and his associates (1942) silk sutures were extruded in only one case postoperatively, in the presence of wound infection, and this subsided within eight weeks following operation, without recurrence of the hernia. Fascial sutures were not recognized in any of the cases at the time of the second or third operation.

TABLE VI

SUTURE MATERIAL USED IN FIRST OPERATION OBSERVED IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

SUTURE MATERIAL	NO. OF CASES	PERCENTAGE
Silk	9	24.4
Absorbable	28	75.6
Total	37	100.0

Duration to Second Operation.—Table VII gives no indication as to the exact time of recurrence. As Iason (1941) stated, if inguinal hernias recur, they will often do so within one month and usually the recurrence can be noted on careful inspection at the time the patient is discharged from the hospital.

TABLE VII

DURATION TO SECOND OPERATION IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

DURATION	NO. OF CASES	PERCENTAGE
1 yr. and under	3	8.1
2 yr.	6	16.3
3 yr.	9	24.3
4 yr.	4	10.8
5 yr.	2	5.4
6 yr.	2	5.4
7 yr.	1	2.7
8 yr.	0	0.0
9 yr.	0	0.0
10 yr.	1	2.7
Over 10 yr.	9	24.3
Total	37	100.0

Hernia Type at Second Operation.—Breaking down the statistics shown in Table VIII reveals the previously mentioned rule that in hernias primarily operated upon at Henry Ford Hospital, the recurrence is usually direct, while in operations done elsewhere, the recurrence is usually indirect. Table IX demonstrates all types found at the final operation, including the six cases which had two previous operations.

Previous Operations.—In this series of 37 consecutive operations for recurrent inguinal hernia, 31, or 83.8 per cent, had had only one pre-

TABLE VIII

HERNIAL TYPE AT SECOND OPERATION IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

FIRST OPERATION AT HENRY FORD HOSPITAL			FIRST OPERATION ELSEWHERE		
TYPE	NO. OF CASES	PERCENTAGE	TYPE	NO. OF CASES	PERCENTAGE
Indirect	3	30	Indirect	16	59.3
Direct	7	70	Direct	5	18.5
			Direct-indirect	2	7.4
			Direct-femoral	1	3.7
			Not known	3	11.1
Total	10	100		27	100.0

vious repair, and 6 or 16.2 per cent had had two previous attempts at repair of the defect. None of the patient's had had more than two previous operations. None of the cases with two previous operations in this series had been operated upon at the Henry Ford Hospital.

Any attempt at repair of a recurrent hernia which has been subject to two or more previous repairs is recognizably more difficult than a primary repair. Tissue defects, plus scarring and obliteration of landmarks, all combine to increase the problem of adequate repair. The first case in our series presented a combined direct-indirect, femoral hernia. Two incisions were made, one over the femoral bulge, and one over the inguinal hernia. The entire peritoneal sac was transposed to the internal ring by the Hoguet maneuver, but the internal ring was so large, that on consent of the patient, orchectomy was performed and the entire internal ring obliterated. Of the remaining 5 cases, two were of the indirect type, and 3 of the direct type, all presenting large sacs over 10 cm. in length.

Truss.—Conclusions based on this review would seem to indicate that the truss is falling into disuse in the treatment of inguinal hernia. As physical examinations are required for employment in our larger industrial concerns, it is evident that persons with hernias are now more frequently seeking surgical repair rather than go on through life with such artificial support as a truss provides. Only 8, or 21.6 per cent, of our patients gave the history of wearing a truss, leaving 29, or 78.4 per cent, who preferred early surgical treatment. It is generally recognized that the trauma produced by wearing a truss results in extensive adhesions and scarring in the region of the hernial site adding to the difficulty in repair. This observation was borne out in our series of operations upon these patients.

Relative Frequency of the Side Involved.—Contrary to the observations of Fallis, (1937) the greater number of our patients presented recurrences on the right side. We offer no explanation for this happening.

Anesthesia.—Spinal anesthesia is used in almost all operations done in the Henry Ford Hospital for inguinal hernias mainly because of its simplicity and the better relaxation which results. Other types of anesthesia are used only when there is some definite contraindication to the spinal anesthetic. General anesthesia is usually avoided, and was used

TABLE IX

RELATIVE FREQUENCY IN THE SIDE INVOLVED IN THIRTY-SEVEN CONSECUTIVE OPERATIONS FOR RECURRENT INGUINAL HERNIA

SIDE	NO. OF CASES	PERCENTAGE
Right	24	64.9
Left	13	35.1
Total	37	100.0

primarily only in cases in which the patient was so apprehensive that it was necessary to give ethylene anesthesia to control him. In one case, where the operation was extensive and the effect of the spinal anesthetic ceased before the operation was finished, ethylene gas was given as a supplementary anesthetic. Local novocain anesthesia was used in one case in which the blood Kline reaction was positive, and it was deemed advisable not to use a spinal anesthetic. The patient is routinely given a barbiturate on call to the operating room, which generally produces the desired sedative effect.

TABLE X

ANESTHESIA USED IN THIRTY-SEVEN CONSECUTIVE OPERATIONS FOR RECURRENT INGUINAL HERNIA

ANESTHESIA	NO. OF CASES	PERCENTAGE
Spinal	33	89.2
Ethylene	2	5.4
Spinal supplemented with ethylene	1	2.7
Local	1	2.7
Total	37	100.0

Size of Sac.—A definite peritoneal sac was observed in all the cases in this series. A sac of 10 cm. or more in length is classed as a large sac, one 5 cm. or more in length, as a medium sac, and a small sac is less than 5 cm. in length.

TABLE XI

SIZE OF SAC IN THIRTY-SEVEN CONSECUTIVE OPERATIONS FOR RECURRENT INGUINAL HERNIA

SIZE OF SAC	NO. OF CASES	PERCENTAGE
Large	14	37.8
Medium	19	51.4
Small	4	10.8
Total	37	100.0

Type of Hernia.—Table XII merely classifies the type of inguinal hernia found at the final operation reported in this series, including the six patients upon which two operations had previously been done. It represents a distribution similar to that found in most series of hernial operations.

Operation.—As has been discussed previously in this article, emphasis was placed upon the use of free fascial strips in the repair of recurrent inguinal hernia until one of us (H.N.H.) became familiar with the McVay procedure. Since that time, the McVay procedure has been used almost exclusively, but may be supplemented with fascia whenever deemed necessary.

TABLE XII

TYPE OF HERNIA IN THIRTY-SEVEN CONSECUTIVE OPERATIONS FOR RECURRENT INGUINAL HERNIA

TYPE OF HERNIA	NO. OF CASES	PERCENTAGE
Indirect	18	48.6
Direct	15	40.6
Direct-indirect (Saddlebag)	2	5.4
Direct-femoral	1	2.7
Direct-indirect-femoral	1	2.7
Total	37	100.0

TABLE XIII

OPERATIVE TECHNIQUE USED IN THIRTY-SEVEN CONSECUTIVE CASES OF RECURRENT INGUINAL HERNIA

OPERATION	NO. OF CASES	PERCENTAGE
Halsted I		
With fascia	5	13.5
Without fascia	3	8.1
Halsted I-McVay		
With fascia	6	16.2
Without fascia	7	18.9
Bassini-McVay		
With fascia	1	2.7
Without fascia	15	40.6
Total	37	100.0

Associated Operations.—Most of the associated operations listed are those which may be found concurrent with the repair of inguinal hernia. Although many surgeons prefer not to repair both sides at the same time in bilateral hernias, we have noticed no ill effects which might be attributed to the performance of the combined operation. In six of our cases a herniotomy was performed on the opposite side at the same sitting. Three of these were for primary hernia and three for recurrent hernia. In cases with an accompanying large hydrocele, we prefer to lift the testis from the scrotum and invert the tunica vaginalis, holding it in place with one or two sutures, thus doing the "bottle" operation, and then returning the testis into the scrotum.

TABLE XIV

ASSOCIATED OPERATIONS IN THIRTY-SEVEN OPERATIONS FOR RECURRENT INGUINAL HERNIA

ASSOCIATED OPERATIONS	NO. OF CASES	PERCENTAGE
Opposite inguinal herniotomy	6	16.2
"Bottle" operation	2	5.4
Orchectomy	1	2.7
Femoral hernia	1	2.7
Umbilical hernia	1	2.7
None	26	70.3
Total	37	100.0

Follow-up.—If the rule stated by Iason (1941) holds true, the results of this series of 37 operations for recurrent inguinal hernia may be held as being quite promising since no recurrences of hernia have been observed to date. It has been difficult to continue an adequate follow-up at the present time because of the continual shifting of population and the induction of men into the armed forces. Almost one-half of our cases have been followed for two or more years, and we shall continue in our efforts to trace the remaining cases for a longer period of time.

Postoperative complications have been few and relatively inconsequential considering the severity of the condition presented. Slight pain has persisted in the region of the operative wound in 13, or 35.1 per cent, of our cases. Atrophy of the testis on the involved side has been noted in one case.

TABLE XV

FOLLOW-UP IN THIRTY-SEVEN CONSECUTIVE OPERATIONS FOR RECURRENT INGUINAL HERNIA

DURATION	NO. OF CASES	PERCENTAGE
3 yr.	4	10.8
2½ yr.	3	8.1
2 yr.	10	27.0
1½ yr.	4	10.8
1 yr.	7	18.9
½ yr.	9	24.4
Total	37	100.0

In Fallis' series (1937) of 200 recurrent inguinal hernia operations, there were 26 recurrences after reoperation (13 per cent). Since 21 of the 26 (81 per cent of the secondary recurrences) were noted within less than two years, our follow-up of almost one-half of our cases for that length of time is especially significant.

SUMMARY AND CONCLUSIONS

1. The factors involved in the recurrence of inguinal hernia are reviewed.

2. The application of the McVay modification of the Lotheissen operation for femoral hernia to recurrent inguinal hernia is presented. This procedure utilizes Cooper's ligament instead of Poupart's ligament.

3. The use of free fascia grafts in recurrent inguinal hernia is discussed.

4. We present a series of thirty-seven consecutive operations for recurrent inguinal hernia, most of which were performed with the use of free fascial grafts or a Cooper's ligament (McVay) herniotomy, done in the Henry Ford Hospital on a single surgical service during the years 1940 to 1942.

5. No recurrences of hernia in the cases which we have been able to follow have been noted to date.

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A STUDY OF RECURRENCES FOLLOWING INGUINAL HERNIOPLASTY

With Report of New Operation

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THERE are few operative procedures of which the results are so little known as inguinal hernioplasty. Halsted[1] once stated that he had not had a recurrence in twenty years. A similar report was made by Torek a few years ago during a symposium at the New York Academy of Medicine. While most surgeons admit a moderate percentage of failures, some put the figure as high as 40 to 50 per cent.

In an attempt to ascertain the true status, two means of approach have been utilized: (1) review and analysis of the current and past literature; (2) a questionnaire.

(1) A review of the important reports in the surgical literature during the past ten years is given in Tables I and II. Analysis of these reports discloses a wide variation in results. For indirect hernias the recurrence rate varies from 0.4 to 33.3 per cent with the average below 10 per cent. For direct hernias the recurrence rate varies from 2.7 to 33.3 per cent with the average between 15 and 20 per cent. Many factors are responsible for this divergence and these will be discussed subsequently.

(2) The following questionnaire was sent to 150 recognized hospitals and universities throughout the country. A few questionnaires were sent abroad. It will be noted that only the essential facts were sought:

1. Date of survey
2. Age of patient
   (a) Younger than twelve years
   (b) Older than twelve years
3. Number of patients operated upon (if bilateral, consider as two)
   (a) Indirect inguinal hernia
   (b) Direct inguinal hernia
   (c) Recurrent inguinal hernia
4. Type or types of operation
5. Number of patients returning for follow-up examination
6. Time between operation and follow-up examination
7. Of the patients with recurrences operated upon, what percentage had had the primary repair at your hospital

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TABLE I

A STUDY OF RECURRENCES FOLLOWING OPERATIONS FOR DIRECT AND INDIRECT INGUINAL HERNIAS

AUTHOR	INDIRECT INGUINAL HERNIAS			DIRECT INGUINAL HERNIAS			TOTAL		REMARKS
	CASES FOLLOWED	RECURRENCES		CASES FOLLOWED	RECURRENCES		CASES FOLLOWED	RECURRENCES PER CENT	
		NO.	PER CENT		NO.	PER CENT			
Erdman[4]	665	21	3.1	313	52	16.7			Halsted and Bassini type operations, Willys-Andrews used for direct hernias
Gibson and Felter[5]	1,451	20	1.3	427	28	6.5			Incomplete follow-up (90%), Halsted, Bassini, Willys-Andrews operations
Taylor[6]	356	30	8	47	14	29			Halsted operation; statistics are for personal follow-up, letter follow-up shows fewer recurrences
Coley[7]	332	28	8.7	85	14	16.4			Bassini operation, all patients were adults
Turner and Eckhoff[8]	115	5	4.3						Bassini operation, 40% in children
Ostfeld[9]			4.3			20	239	5.4	Bassini operation, about 70% direct follow-up
Cattell and Anderson[10]	123	6	4.6	51	4	7.8			Bassini type operations, fascial sutures for direct hernias
Page[11]			20.2			25			Bassini operation in adult males
Fallis[12]			7.4			11.6			Halsted operation in most patients and occasionally the Bassini procedure; silk technique in 96%
Glenn and McBride[13]	253	6	2.37	32	2	6.21	285	2.1	Halsted repair, silk technique
Fallis[14]				154	18	11.6			Rectus sheath sutured to Poupart's ligament
Burdick, Gillespie, Higgenbotham[15]	202	35	17.3	310	80	25.8			Fascial sutures used in Gallie type repair
Grace and Johnson[16]			21.2			32			All patients over 50 yr., Bassini repair
Parsons[17]	173		9.8	22		13.6			(a) Chromic catgut used, Halsted type repair
	278		2.16	89		4.49			(b) Silk sutures used, Halsted type repair

Robins[18]				27					Fascial repair with strips from external oblique
Novak and Rigler[19]	648	34	5.2	227	20	8.8	875	6	Bassini operation, local anesthesia
Longacre[20]	474	26	5.6	115	8	6.9			Halsted or Bassini type operation; silk, catgut, and fascial sutures
Quigley[21]							78	11	Ferguson, Bassini, and Halsted operations, all patients over 50 yr.
Shelley[22]	1,668		7.2						Bassini operation or modification; catgut, silk and fascial sutures; recurrences 6.9% with fascia
Shelley[23]				458		14.8			Bassini type operations, catgut and silk and fascia used, recurrences with fascia 10.4%
Shelley[24]	305	4	1.9						Congenital hernias, 63% below 20 yr. of age
Harrison[25]	46			14					LaRocque incision, patch of fascia sutured over defect, follow-up very inadequate
Joyce[26]	495			99			544	2.94	Internal oblique muscle sutured to Poupart's ligament with fascial strips
Wakely[27]							851	5.4	Bassini type repair
Sutton[28]							91	2.2	Intraperitoneal operation of LaRocque
Gray[29]	29	1	3.5	10	1	10	39	5.1	Rectus sheath sutured to Poupart's ligament with fascial strip from external oblique
Williamson[30]	150	6	4	4	0	0	154	3.9	Fascia lata or strips from external oblique used for repair, Bassini type repair
Estes[31]	271	1	0.4	72	2	2.7	343	0.99	Rectus sheath sutured to external oblique aponeurosis and fascia imbricated
MacFee[32]	3	1	33.3	9	3	33.3	12	33.3	Cord transplanted to femoral canal, all patients over 50 yr., difficult cases
Stein[33]	62	0	0	26	3	11	88	3.4	Internal oblique aponeurosis incised and the flap sutured to Poupart's, internal ring narrowed

TABLE II

RESULTS OF OPERATIONS FOR RECURRENT HERNIAS

AUTHOR	CASES FOLLOWED	RECURRENCES		REMARKS
		NO.	PER CENT	
Erdman[4]	51	12	23.1	Halsted and Bassini type operations, Willys-Andrews used for direct hernias
Glenn & McBride[13]	20	6	30.0	Halsted repair, silk technique
Fallis[34]	200	26	13.0	Transversalis fascia sutured to Poupart's ligament, Halsted and Bassini type repairs, silk sutures
Burdick, Gillespie, Higgenbotham[15]	262	92	35.2	Fascial sutures used in Gallie type repair
Grace & Johnson[16]			34.0	All patients over 50 yrs. Bassini repair
Parsons[17]	22		25.0	Chromic catgut used, Halsted type repair
	42		7.6	Silk sutures used, Halsted type repair
Longacre[20]	69	8	11.6	Halsted or Bassini type operation; silk, catgut, and fascial sutures
Wakely[27]	59	23	38.6	Bassini type repair
Gray[29]	4	0	0	Rectus sheath sutured to Poupart's ligament with fascial strip from external oblique
Williamson[30]	9	1	11.1	Fascia lata or strips from external oblique used for repair, Bassini type repair
Estes[31]	17	3	17.6	Rectus sheath sutured to external oblique aponeurosis and fascia imbricated
MacFee[32]	7	1	14.0	Cord transplanted to femoral canal, all patients over 50 yrs. (difficult cases)
Stein[33]	13	1	7.6	Internal oblique aponeurosis incised and the flap sutured to Poupart's; internal ring narrowed

8. Number of recurrences
   (a) Indirect inguinal hernias
   (b) Direct inguinal hernias
   (c) According to type operation
9. Remarks

Only thirty-five responses were obtained, of which eight contained significant data. Three hospitals apologized for their inability to give the desired information owing to inadequate personnel. Very little information was obtained from these questionnaires beyond that already found in the literature. The following are specimen responses.

1. Patients do not return for examination but are contacted by letter, follow-up for six months postoperatively. Recurrences: indirect, 2.73 per cent; direct, 3.09 per cent (Walter Reed Hospital).

2. The time between operation and follow-up varied from six months to two years. The number in each group was not stated (New York Hospital).

3. Rhode Island Hospital reported 103 cases of which 54 were examined in three months with a 10 per cent recurrence rate.

4. No statement as to time of follow-up (Indiana University).

As can be observed from the preceding information there is a great discrepancy in the reported results and frequently an inadequate knowledge of the end results. Some of the causes of this discrepancy may be summarized as follows.

First, a large percentage of patients with recurrence do not consult the original operator. This is definitely shown by the fact that of the patients with recurrent hernias that present themselves at any hospital, almost 75 per cent had been primarily operated upon at another hospital.[2]

Second, the time elapsing between the operation and the follow-up is frequently too short. Examinations should continue for at least two years and probably longer. While most recurrences are observed in the first year after operation they may appear after twenty years.

Third, the patients have not been personally examined but have been permitted to report by mail and it is well known that many patients have a recurrence without knowing it.

Fourth, the percentages are occasionally calculated on the basis of the operations instead of on the number of cases re-examined at the follow-up clinic.

Fifth, many reports group hernias in children with those of adults. As recurrences in the former are very infrequent even after the simplest form of operation, inclusion of these age groups in the reports gives a much lower general percentage recurrent rate. Coley and Hoguet,[3] reporting on 5,000 cases, record a very low percentage of recurrence. However, over 50 per cent of the patients in this series were under 12 years of age.

There is a growing realization that operation has failed to cure inguinal hernia in a large percentage of patients. The figures often given for recurrences (2 to 7 per cent for indirect hernias; 10 to 15 per cent for direct hernias; 25 to 35 per cent for recurrent hernias) appear entirely too low.

We would suggest the following method for ascertaining the true figures. A clearing house should be set up, manned by some national

organization such as the College of Surgeons. A report of every recurrent hernia, whether operated on or not, should be sent to this clearing house which would then notify the hospital at which the primary operation had been done. This hospital in turn should send an abstract of the original finding back to the clearing house.

CAUSES OF RECURRENCE

We believe that recurrences are dependent upon one or several of the following factors.

1. Persistence of original structural weakness or defect
   (a) Weak internal oblique muscle
   (b) Weak or torn transversalis fascia
   (c) Long mesentery
   (d) Obesity (?)
2. Inadequate operative procedure and technical errors
   (a) Failure to narrow internal ring
   (b) Internal oblique muscle sutured to Poupart's ligament causing atrophy and paralysis
   (c) Interference with blood supply either by stripping the areolar tissue from the aponeurotic structures, tying ligatures too tightly, or inclusion of too much tissue in the ligature or suture
   (d) Incorrect or insufficient resection of neck of sac
   (e) Inclusion of omentum in sac ligature
   (f) Trauma, incomplete hemostasis, suppuration
   (g) Failure to recognize concomitant indirect and direct hernia
   (h) Use of the same technique for direct hernia as for indirect hernia
   (i) Division of nerves (?)
   (j) Improperly formed knots, early absorption of suture material
   (k) Bilateral operation at one sitting, tending toward more hasty and traumatic dissection, incomplete hemostasis, infection, prolonged anesthesia, pulmonary complications
3. Postoperative increased intra-abdominal pressure.
   (a) Cough
   (b) Early intercourse
   (c) Excess weight lifting
   (d) Abdominal tumor or ascites
   (e) Constipation
   (f) Urinary obstruction (prostatic hypertrophy)

TYPES OF RECURRENCES

(1) The recurrence may appear as an indirect hernia. The statement has often been made that an indirect inguinal hernia, properly operated upon, cannot recur as such, the recurrence being considered either a new hernia or a direct one. We do not believe the facts bear out the correctness of this statement. Recurrent hernias frequently protrude

directly through the internal ring with a typical indirect hernial sac, even though at the primary operation the sac had been recognized and removed. The elasticity of the peritoneum is well known and if the internal ring had not been narrowed and protected at the primary operation the possibility of an outpouching of the peritoneum through the patent ring is always present. Every surgeon has seen these rings frequently stretched to a diameter of 4 to 5 cm. Adequate closure of the ring leaving only sufficient space for the exit of the cord structures is both logical and imperative.

(2) The recurrence may appear as a direct hernia as a result of one or more of the following contingencies: (a) The primary indirect hernia may have been completely cured, the secondary hernia appearing as a direct one; (b) the direct hernia may have been present but not noted at the first operation; (c) selection of the naturally weak route of Hesselbach's triangle for repair of a femoral hernia may result in a subsequent direct inguinal hernia; (d) cure of the direct hernia may have been difficult because of inadequate operative utilization of the natural defenses at this area. The interrelationship between direct inguinal and femoral hernias was brought very forcibly home to one of us when, after a case of bilateral direct hernias was cured, the patient presented himself after one year with bilateral femoral hernias which had not been present at the time of the primary operation.

(3) A spigelian hernia may result. This is a hernia along the semilunar line. At this site there is an area of inherent weakness, covered only by the fascia of the internal oblique muscle, without any underlying muscular structure and situated on a plane cephalad to that of the internal ring. If the internal oblique fascia is cut at this point one comes directly upon the transversalis fascia and peritoneum. In using our technique it is imperative that the incision of this fascia not be extended beyond this weak point. Herniation through this space results in a bulge when the patient attempts to raise his trunk from a horizontal to a sitting posture without the aid of his arms. This was noted in one of the earlier cases.

PREVENTION OF RECURRENCE

Prevention depends upon the adherence to certain principles, the truth of which has been proved. These are (1) elimination of the causes as far as possible; (2) re-establishment of the natural physiologic and mechanical forces; (3) selection of the proper procedure; (4) avoidance of technical errors in the course of the primary operation. As all these factors cannot be completely controlled in every patient, it is evident that we cannot hope to attain perfect results in the treatment of hernia. However, if we are able to reduce materially the number of recurrences, we can claim considerable progress.

We have attempted to adhere to these principles in our technique, the details of which have been previously reported by one of us

(H. E. S.). The essential features in the repair of indirect hernia are elimination of the sac, narrowing of the internal ring, forming a flap of the internal oblique aponeurosis, and suturing it to Poupart's ligament thereby improving the trap-door action of the internal oblique muscle. In direct hernias there are two types to consider: (a) those cases in which a distinct opening in the transversalis fascia and a fusiform sac are noted, and (b) those in which there is simply a bulge in the transversalis fascia and underlying peritoneum. In the former group, elimination of the sac by excision or infolding is necessary, followed by closure of the defect in the transversalis fascia; while in the latter, the transversalis fascia is incised medially to the curving free edge of the internal oblique muscle and the cut edge of fascia thus formed is sutured to Poupart's ligament posterior to the line of suture between the internal oblique aponeurosis and Poupart's ligament. Unless the sac is very large it is not necessary to open and excise it in this, the usual type of direct hernia.

The importance of the internal oblique muscle has only lately been recognized but not sufficiently stressed. Probably in the majority of surgical clinics, the curving free edge of the muscle is sutured to Poupart's ligament. It cannot be denied that this step in the original Bassini operation was a great advance over the types of operation then performed. However, we feel strongly that under no circumstances should the internal oblique muscle be sutured to the inguinal ligament. This applies equally to operations for direct or indirect hernia. Such suturing immediately immobilizes and causes subsequent disuse of the muscle and this is one of the factors in the causation of recurrence. The internal oblique muscle has a definite function to perform. Contraction, following increased intra-abdominal pressure, tends to straighten out its line and thus close the space existing between the free edge of the muscle and Poupart's ligament in the upper three-quarters of the canal, at the site of the internal ring.

Proper exposure of the lower portion of the inguinal canal is essential to the cure of a direct hernia and to the prevention of direct hernias following operation for indirect hernia. An adequate incision extending down to the pubic spine followed by separation of the underlying tissues by clean dissection will accomplish the desired result. It should not be necessary to retract forcibly at this point, although this is usually done, causing undue trauma.

Avoidance of tension in approximation of the tissues is even more important. However, the usual method of suturing of the conjoined tendon (a fixed structure rarely more than three-quarters of an inch in length) to the lowest or most median portion of Poupart's ligament, another fixed structure, cannot be accomplished without tension. Necrosis of tissue or cutting through of the suture is bound to result in the majority of cases, whether absorbable or nonabsorbable suture

material is used. It is well known that this lower angle is a most vulnerable area. The technique of developing a flap from the internal oblique aponeurosis and suturing it to the lowest portion of Poupart's ligament absolutely fulfills this first principle of all plastic work and at the same time establishes a complete and firm barrier.

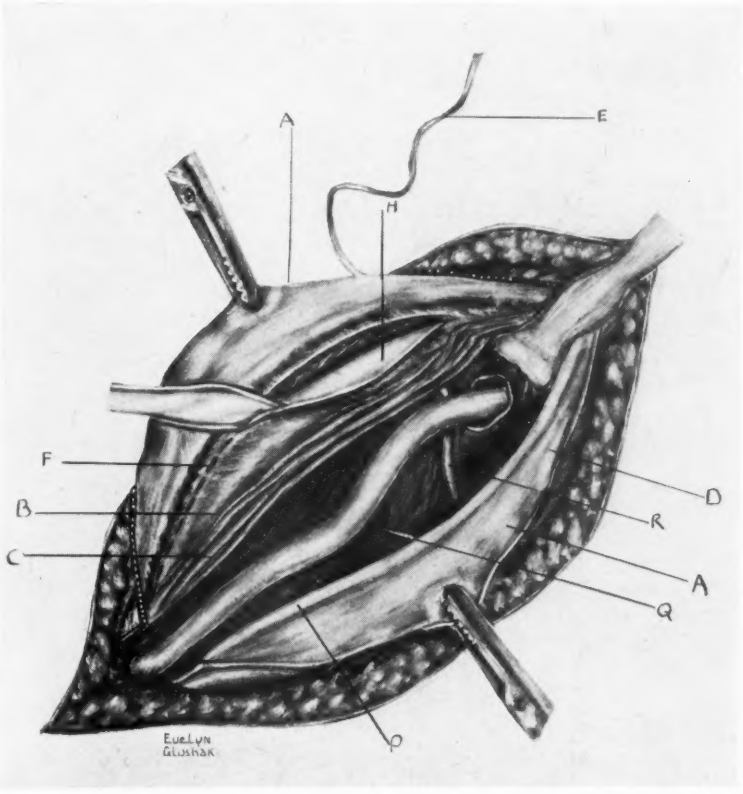

Fig. 1.—*A*, Aponeurosis external oblique muscle; *B*, aponeurosis internal oblique muscle; *C*, internal oblique muscle; *E*, fascial strip from external oblique aponeurosis; *F*, incision of aponeurosis of internal oblique; *H*, flap of aponeurosis of internal oblique; *P*, Poupart's ligament; *Q*, transversalis fascia; and *R*, epigastric vessels.

A great deal of attention has been devoted recently to the type of suture material used. It is questionable whether this is a reasonable and significant factor. These discussions have been repeated in the surgical literature time and again and the relative merits of wire, silk, catgut, and fascial sutures have been thoroughly debated. The important considerations are tensile strength tissue irritation, absorbability, and predisposition to infection. Of late, fascia is being discarded and silk, cotton, wire, and plastic sutures are receiving more attention. The use of very fine chromic catgut for suture material also has its advocates. Parsons believes that linen predisposes to infection, while silk causes practically no tissue reaction. In spite of the care devoted to proper selections of suture material, many recurrences are being

reported with each type. As pointed out frequently, it seems illogical for the suture material to be of greater tensile strength than that of the tissues approximated. The main reason for our better results is probably due to the lesson we have learned of doing cleaner, sharp dissection and avoiding the errors as enumerated above.

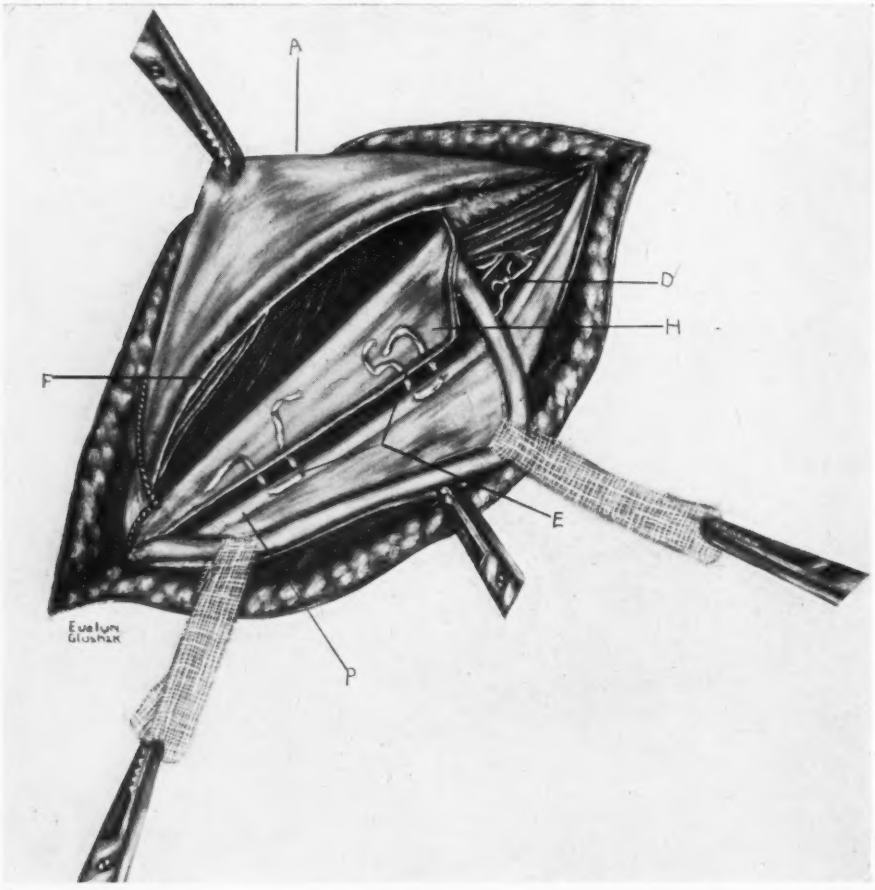

Fig. 2.—*A*, Aponeurosis external oblique muscle; *D*, suture through internal (deep) ring; *E*, mattress sutures uniting internal oblique fascia to Poupart's ligament; *F*, cut edge internal oblique fascia; *H*, fascial flap internal oblique muscle; and *P*, Poupart's ligament.

The technique of our operation for the cure of recurrent hernia differs only in a few details from the procedure for the cure of the primary hernia. It is advisable to start the incision higher than the site of the previous operation so as to expose the external oblique aponeurosis cleanly and follow down from this point. The possibility that the cord had been transplanted subcutaneously at the primary operation must be borne in mind and due care taken to avoid injury. Sharp dissection is preferable. The sac, especially of the indirect variety, being usually adherent to the surrounding tissues, is separated

and dealt with. The internal oblique muscle will usually be found to be partially adherent to Poupart's ligament. This must be severed completely and restored to its former free state. Even if previous suppuration has destroyed a large part of the external aponeurosis, it is always possible and essential to expose the internal oblique aponeurosis and from it fashion the firm flap to be sutured to Poupart's ligament. If the internal ring is large it must be narrowed by taking a few mattress sutures approximating its edges. In the earlier series, fascial

TABLE III

STATISTICS AUTHOR'S OPERATION

TYPES	NUMBER	FOLLOW-UP	NO. OF RECURRENCES	PER CENT
Indirect	135	114	3*	2.6
Direct	60	51	4	7.8
Indirect and Direct	18	15	1	6.6
Recurrent	24	19	2†	10.0
Total	237	199	10	5.0

*All recurred as direct hernias, 1 yr., 15 mo. and 3 yr. postoperatively.

†Pt. 1, G. K., paretic, aged 51 years, sliding recurrent.

Pt. 2, T. K., aged 64 years, Poupart's ligament almost completely destroyed at previous operation. Suture material in pt. I and II, autogenous strips of fascia.

TABLE IV

LENGTH OF FOLLOW-UP PERIOD*

	LESS THAN ONE YEAR	BETWEEN 1 AND 2 YR.	OVER 2 YR.
Indirect	19	17	78
Direct	4	3	44
Indirect and direct	4	5	6
Recurrent	2	1	16

*All patients examined personally by the authors.

strips were taken from the cut edge of the external oblique aponeurosis and fashioned as sutures according to the McArthur technique. In the later cases very fine silk or double zero chromic have been used. Subaponeurotic transplantation of the cord has been done in most but not all cases, particularly in the direct hernias. The results of this operation are illustrated in Tables III and IV.

CONCLUSIONS

1. There is a wide discrepancy in the reported results.

2. This can be corrected by adopting a uniform system of follow-up studies.

3. A sounder understanding of the anatomic, physiologic, and mechanical forces involved in the causation and cure of inguinal hernia is essential.

4. The application of these principles to the proper choice of operation is illustrated in the techniques described.

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SURGICAL TREATMENT OF CARCINOMA OF THE PAPILLA OF VATER

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LESIONS of the papilla of Vater challenge the ingenuity and ability of the surgeon. This tiny eminence in the duodenal mucosa provides in most persons the principal exit to the gastrointestinal tract for the secretions of the biliary tract and the pancreas. Tumors in this region are not rare and since they are small, grow slowly, metastasize late if at all, and provide early signs of their presence, they should be amenable to surgical treatment. Thirty years ago Upcott[1] wrote, "There is probably no position within the body, outside the central nervous system, where a growth, while yet so small, is heralded by more widespread symptoms." Yet since McNeal[2] first described carcinoma of the papilla of Vater in 1835, as far as we could ascertain less than 125 attempts to remove the lesion have been reported in the literature to 1942, and the disease is rarely diagnosed clinically.

Until recently the major obstruction to the perfection of a method of resection of these lesions was the belief that the permanent interruption of the pathway of pancreatic external secretions was not compatible with life. Other factors more or less responsible for the lack of progress were enumerated by Judd and Hoerner.[3] These are (1) the insidious onset of the disease, (2) the generally poor condition of the patients, (3) the relative inaccessibility of the lesion, (4) the proximity of important structures which cannot be sacrificed, and (5) the extreme technical difficulties of resection. The relatively few attempts at resection for tumors in this region that have been made from the time of Codivilla[4] in 1898, to 1935, when Whipple and his co-workers[5] devised a two-stage operation, and even to 1941, when Trimble and his associates[6] devised a single stage operation, have not been uniformly successful. Palliative operations obviously leave much to be desired. If possible, a successful technique should embody the tenets of surgical treatment of carcinoma, that is block removal of the tumor with its contiguous structures and lymphatic pathways of drainage. Each step in this direction is progress so that Whipple[7] and Trimble and his associates[6] deserve much credit for their suggestions which will be described more fully later in this communication.

The purpose of this study is to present the results of surgical treatment of carcinoma of the papilla of Vater in the Mayo Clinic and to consider the types of treatment available. From 1908 to November, 1941,

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inclusive, resection for carcinoma of the papilla of Vater was carried out in nine cases. In the same period palliative operation only was performed in twenty-three cases, but carcinoma of the papilla of Vater was proved by biopsy or necropsy. In three more cases an exploratory operation was performed but proof of the nature of the tumor was obtained by biopsy or necropsy. In about seventy additional cases the surgeon felt that in all probability the lesion for which a palliative operation was necessary was a carcinoma of the papilla of Vater, although no tissue was removed for examination. In twenty of these, the surgeon felt and described a tumor at the papilla and stated its location in positive terms. These twenty cases are presented as a special group for comparative purposes.

DEFINITION, ETIOLOGIC FACTORS, AND INCIDENCE

Strictly speaking, carcinoma of the papilla of Vater is limited to the tiny eminence forming the exit of the ampulla. The regional anatomy is so minute (the entire region may be circumscribed by a circle 1 cm. in diameter) that the term has come to be applied to any tumor arising from any one of six sources since the symptoms, clinical course, and treatment of all are identical. Outerbridge[8] suggested six plausible points of origin of these tumors: (1) the epithelial lining of the ampulla itself; (2) the epithelium lining the common duct at its lower end; (3) the epithelium of the terminal portion of the pancreatic ducts; (4) the duodenal mucosa directly covering the papilla; (5) the glands of Brünner on rare occasions, and (6) aberrant pancreatic tissue.

Carcinoma of the papilla of Vater and the ampullar region is not a rare disease. About 55 to 65 per cent of carcinoma of the duodenum is periampullar in origin.[8, 9] Probably carcinoma of this region is encountered in about 0.2 per cent of necropsies.[10, 11]

The causative factors of these tumors are unknown. Carcinoma of the gall bladder is associated with lithiasis in about 80 per cent of cases, but choledocholithiasis is associated with carcinoma of the papilla of Vater present in only from 15 to 25 per cent.

PATHOLOGIC ASPECTS

The gross and microscopic pathologic changes in many of the cases included in this article were studied by Baggenstoss.[10] The growths were generally small, firm, nodular masses from 1 to 3 cm. in diameter, protruding into the lumen of the duodenum. Many were polypoid or had ulcerated. All had risen from glandular elements (Fig. 1). Metastasis was found late when it occurred at all. Outerbridge reported that evidence of metastasis was found at necropsy in only 22 per cent of 110 cases.

CLINICAL CONSIDERATIONS

The appalling fact that the presence of these tumors rarely had been recognized before necropsy or exploratory surgical procedures led

Sharpe and Comfort[12] to study forty cases of carcinoma of the papilla of Vater in an attempt to aid timely and accurate diagnosis. In only one of the forty cases had the diagnosis been made prior to operation, but in thirty-eight some obstruction to the common duct was evident. The history and clinical observations were not typical. The disease was not always painless nor was the jaundice always progressive. Since the

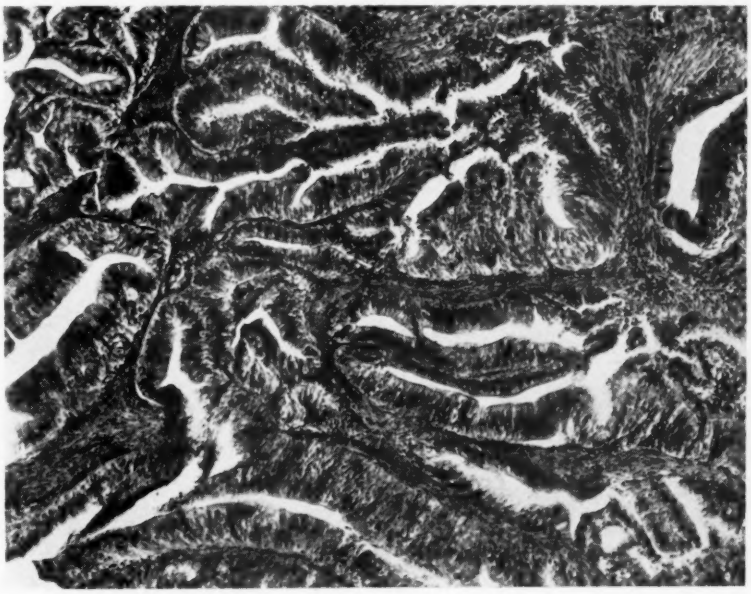

Fig. 1.—Adenocarcinoma of ampulla, grade 1; cellular differentiation is apparent with the production of well-formed glandular spaces. The carcinoma cells are tall and fairly uniform in size (×60).

disease simulated both obstruction to the common duct and hepatogenic jaundice, the decision to resort to surgical intervention was often difficult to make. Intrahepatic jaundice is not a surgical problem but any mechanical obstruction to the common bile duct is. The hope of successful surgical treatment of any malignant disease lies in early diagnosis, and any patient who displays evidence of obstruction to the common duct should be given the benefit of exploration if those symptoms persist longer than six to eight weeks and no adequate explanation is found. Careful study will usually eliminate hepatogenic jaundice in that period of time.

Differential diagnosis in the presence of a patent orifice with partial obstruction of the common bile duct is difficult. Benign stricture, stones in the common duct, and carcinoma of the head of the pancreas are a few conditions that must be considered. The treatment of all of these entities is surgical, however, and surgical intervention should be instituted at the earliest possible moment. Chronic interstitial pancreatitis, hepatogenic jaundice, and toxic hepatitis caused by various ingested

agents are other conditions with which periampullar carcinoma may be confused and which are not benefited by surgical treatment. If benefit is to be derived from the characteristic small size of the lesion, its low grade of malignancy, and its reluctance to metastasize, early diagnosis is essential.

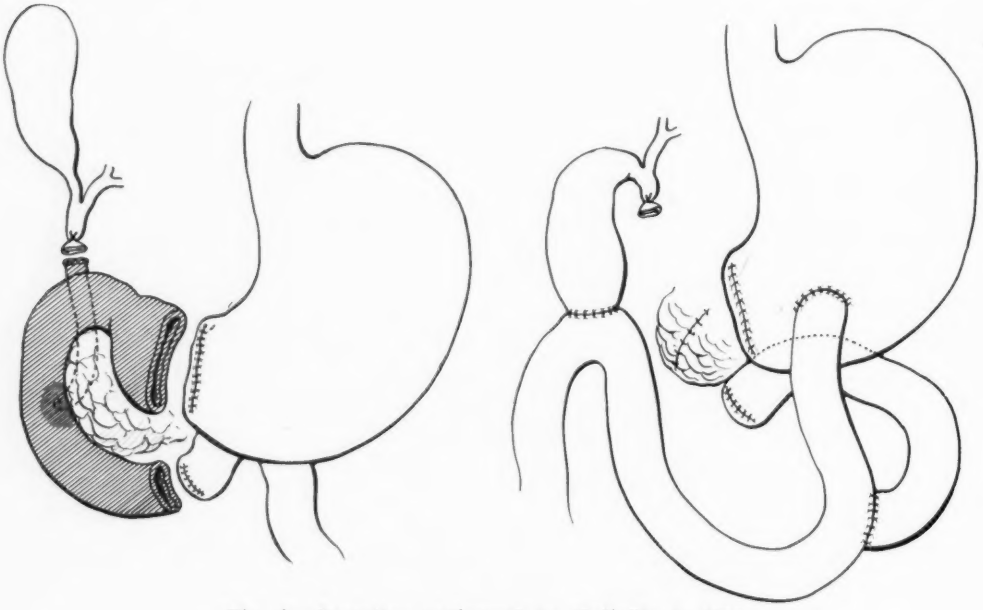

Fig. 2.—Operation performed by Codivilla in 1898.

TREATMENT

The treatment of this disease is surgical. The tumor may be excised by any of several methods to be described, or a palliative short-circuiting of the biliary route may be performed.

Development and Reported Results of Surgical Procedures.—Halsted[13] first excised a growth situated at the papilla of Vater on Feb. 14, 1898. This was performed transduodenally and a large piece of duodenum was excised with the growth. Choledochoduodenostomy was performed and three months later, May 5, 1898, it was necessary to perform cholecystoduodenostomy. The patient lived for about seven months. W. J. Mayo[14] performed cholecystostomy on a patient Nov. 3, 1900, followed by excision of a tumor of the ampulla of Vater, Jan. 31, 1901. The patient lived nine months. Several operations involving the pancreas and not the papilla of Vater preceded these two pioneering attempts. Of these reports, all of which were collected by Sauvé[15] that of Codivilla,[4] in 1898, is particularly worthy to be recorded (Fig. 2). The lesion in his case involved the pancreas also, but he excised en bloc the head of the pancreas, a large portion of the duodenum and pyloric end of the stomach, and re-established gastrointestinal continuity by means

of a Roux Y gastrojejunostomy. Continuity of the biliary tract was maintained by cholecystojejunostomy performed over a Murphy button. This was probably the first example of the one-stage operation now recommended by Trimble and his associates.[6]

Sauvé[15] not only collected reports of the operations previously performed but, in 1908, suggested the first true two-stage operation aimed at removal of the tumor. In his first stage Sauvé performed only gastroenterostomy, and resected the necessary portion of duodenum with its contiguous structures at the second operation. Usually cholecystojejunostomy was used to maintain biliary continuity.

Outerbridge,[8] in 1913, reviewed 110 cases of carcinoma of the ampulla. Resection had been performed in only twenty-two and in all but five of these, transduodenal excisions only were performed. There were eight primary surgical deaths; five more patients died in a few weeks, and only one patient lived three and three-fourths years. Cohen and Colp[16] collected all the reports of cases in which operation had beeen performed, to 1925, and showed the discouraging results to that time. They reported a gross mortality of more than 40 per cent from all types of procedure in the fifty-nine cases reviewed. Fulde,[17] in the same year, reviewed fifty-two cases and reported a similar mortality. Hunt and Budd[18] collected seventy-six cases of periampullar carcinoma in 1935, in which resection had been done; fifty-nine of these were in Cohen and Colp's series and eighteen were added by Hunt and Budd.

In 1935, Whipple, Parsons, and Mullins[5] gave great impetus to interest in the field by describing their two-stage operation and reporting three cases. This operation embodied the principles of surgical treatment of carcinoma, in that the tumor was removed en bloc with its lymphatic drainage and contiguous structures. In the first stage of this operation (Fig. 3) posterior gastroenterostomy was done, the common bile duct was ligated and cut distal to the patent cystic duct, and cholecystogastrostomy was performed to the anterior wall of the stomach. Three to four weeks later the second stage was performed. The pancreaticoduodenal and gastroduodenal arteries were severed, wide excision of the descending portion of the duodenum and excision of a V-shaped portion of the head of the pancreas were carried out, the pancreatic ducts were ligated, and the denuded pancreatic surface was covered.

Whipple, Parsons, and Mullins[5] did not attempt to re-establish the continuity of the duodenum or provide exit for external pancreatic secretions. The effect on the liver of such patients after partial pancreatectomy has been performed is unknown. It is well known that in the presence of hyperinsulinism and adenomas of the pancreas, large amounts of pancreatic tissue can be removed safely. Berg and Zucker[19] described early degenerative changes and infiltration of the liver with fat in completely depancreatized dogs and in those dogs in which the pancreatic ducts have been completely obstructed for long periods.

Dragstedt[20] confirmed at least the effect of pancreatectomy and prevented the hepatic damage by administration of lipocaic. Boyce and McFetridge,[21] however, found that the external secretions can be excluded completely without permanent harm if no pancreatic tissue has been removed. If partial pancreatectomy was performed they found that lecithin, choline, or pancreatic substance would protect the liver from serious damage. Snell and Comfort[22] reported fatty infiltration of the liver in the presence of pancreatic lithiasis and Cole[23] suggested that such changes in the liver accompany fibrosis of the pancreas.

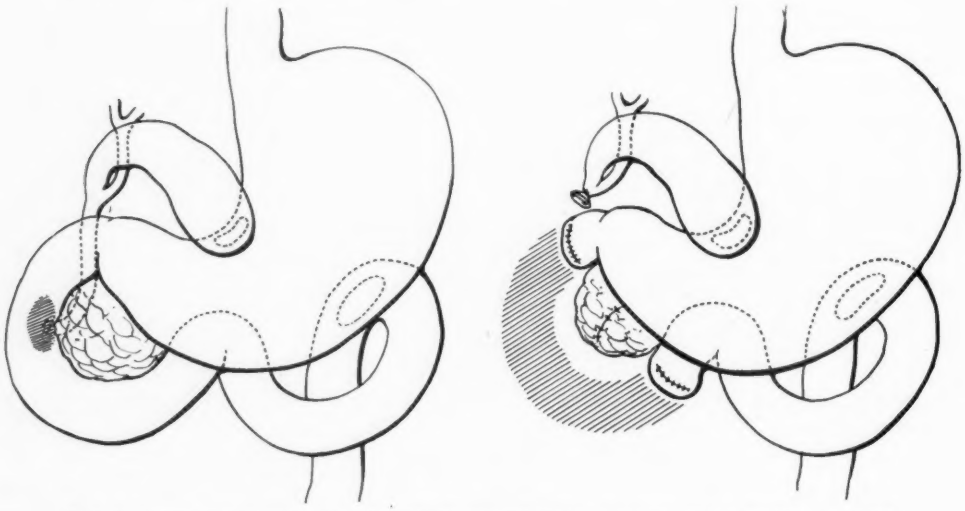

Fig. 3.—Two-stage operation described by Whipple, Parsons, and Mullins in 1935.

The incidence of cholangitis and cholecystitis occasioned by the cholecystogastrostomy was high after the operation devised by Whipple, Parsons, and Mullins.[5] Brunschwig,[24] in 1937, first used a loop of jejunum to establish biliary continuity and performed cholecystojejunostomy and an end-to-side jejunojejunostomy in the first stage of this operation. Whipple,[7] in 1938, described the modified operation now bearing his name (Fig. 4). This, too, was done in two stages. In the first stage, the common duct again was ligated and severed below the patent cystic duct. The jejunum was severed, the distal end was used for an antecolic cholecystojejunostomy, and the proximal end was reimplanted after the Roux Y principle in an end-to-side jejunojejunostomy 10 to 12 cm. below the cholecystojejunostomy. At the second stage, three to four weeks later, posterior gastroenterostomy and radical resection of the second portion of the duodenum, wide of the tumor, and removal of a wedge-shaped piece of the head of the pancreas were done.

Kafka[25] recently reported 115 cases in which some type of operation was done. In twenty-one of these some type of resection resulted in a mortality rate of 47.6 per cent. Orr[26] collected the fifteen cases reported

in the literature, to 1941, in which the Whipple operation was performed; five deaths (33.3 per cent) had occurred. One of the patients who survived the operation lived thirty-two months; the others were not adequately followed. Hunt[27] summarized the results of operation in 124 cases from 1898 to 1941 inclusive. He found the surgical mortality rate as follows: 29.0 per cent in ninety-three cases of transduodenal excision; 40.0 per cent in five cases of retroduodenal excision; 45.4 per cent in eleven cases of resection of the duodenum with implantation of the common duct or common duct and pancreatic ducts and end-to-end anastomosis of the duodenum, and 26.6 per cent in the fifteen cases of

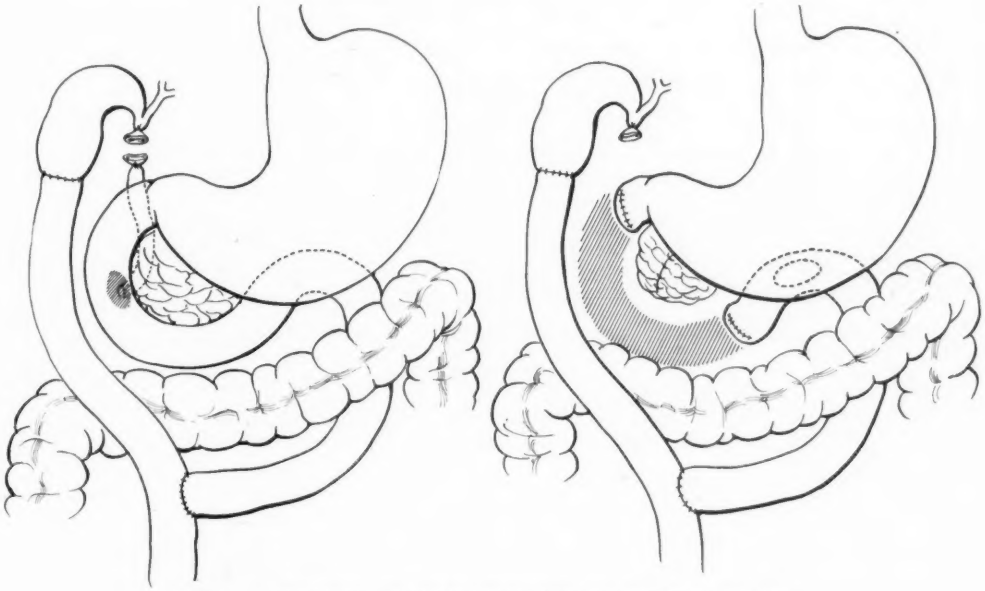

Fig. 4.—Two-stage operation described by Whipple in 1938.

resection of the duodenum and head of the pancreas. There were thirty-eight surgical deaths in the 124 cases considered in his review, a mortality rate of 30.6 per cent. Hunt[27] analyzed further the ninety-three cases in which transduodenal excision was performed. In the twenty-one cases in which transduodenal excision only was performed, eight deaths (38.0 per cent) occurred; in the thirty cases of transduodenal excision with reimplantation of the common duct, or common and pancreatic ducts, five deaths (16.6 per cent) occurred; in the twenty-seven cases in which transduodenal excision with reimplantation of the common or pancreatic duct with establishment of internal or external biliary drainage was performed, seven deaths (25.9 per cent) occurred, and in the fifteen cases in which transduodenal excision without reimplantation of the common or pancreatic duct but with establishment of internal or external biliary drainage was performed, seven deaths (46.6 per cent) occurred.

There is no more comprehensive review of the operative mortality, cause of death, and subsequent course than this most recent publication of Hunt's. Orr's[28] discussion of this article is pertinent. He stated: "Following palliative operation a patient with proven carcinoma of the ampulla has been known to live thirty-three months; after transduodenal resection patients have lived four to twenty-two years; and after resection of the duodenum and pancreas one patient has lived thirty-four months, although the average length of life in each of these groups is much shorter." Orr[28] summarized the findings of various authors concerning the average time of survival of patients who had carcinoma of the ampullar region as follows: 7.3 months when no treatment was given (Outerbridge); 7.7 months when palliative operation was employed (Judd and Parker); eight months when treatment with radium and roentgen rays was given (Pack and McNeer); more than 1.7 years after radical operation according to Hunt's data on the thirty patients in his series who had died, and more than 2.5 years after radical operation according to Hunt's data on thirty-four patients who were living at the time of his report. In many of the cases in Hunt's last group follow-up data were not recorded so the results may be even better. However, as noted by Orr and shown in Hunt's series of cases collected from the literature, the less radical procedures of transduodenal excision or resection have a lower mortality rate and a small number of patients have survived relatively long periods.

Trimble and his associates[6] have recently described a one-stage operation for tumors in this region which it is suggested has removed all of the objections to the operations previously described (Fig. 5). In this operation the pyloric end of the stomach, the first and second portions of the duodenum, the distal third of the common bile duct, and a wedge-shaped piece from the head of the pancreas are resected en bloc. The duodenal stump is closed and the raw surfaces of the remaining pancreas carefully approximated. Gastrointestinal continuity is reestablished by a complete antecolic isoperistaltic terminolateral gastrojejunostomy. Distal to this anastomosis the stump of the common bile duct is implanted into the jejunum.

Transduodenal Excision or Resection.—If the tumor is small and the patient is in poor condition, transduodenal excision or resection must be considered. Eight such operations were performed at the Mayo Clinic from 1908 to Nov., 1941, inclusive (Tables I and II). All were on men. Symptoms of obstruction to the common duct had been present from three weeks to five and one-half months prior to the first operation. The correct diagnosis was not made in any case before the first operation was performed. The mortality rate was 37.5 per cent. Although many of these cases have been reported previously and are a part of

Hunt's collected series of 124 cases, they are listed in Table III to complete the record.

Excision.—Three of these eight patients (Cases 1, 4, and 7, Tables II and III) underwent transduodenal excision of the tumor without disturbance of the continuity of the common duct and duodenum (Fig. 6*a*). The tumors in these three cases were small and well localized and distant metastatic growths were not demonstrable. One patient (Case 1, Table II) died of hepatic insufficiency eight days after

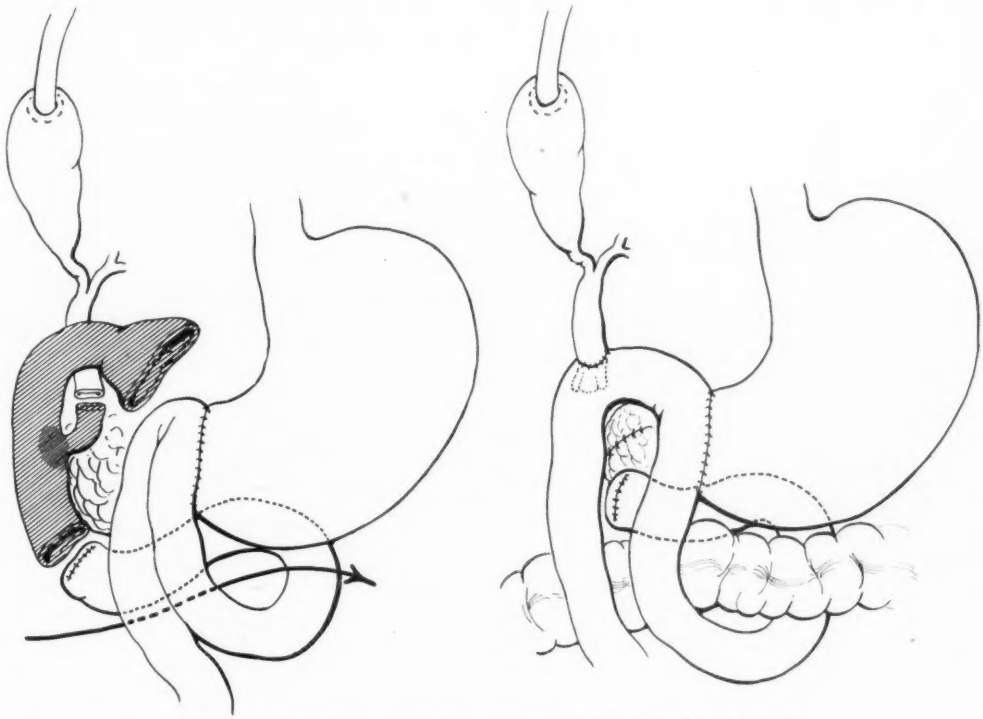

Fig. 5.—One-stage operation suggested by Trimble in 1941.

operation. Internal biliary drainage was established in two of the three cases and no attempt was made to arrange a new permanent route for bile and pancreatic secretions in one case because the common duct seemed to be patent. This patient (Case 4, Table II) lived thirty-five months and died of metastatic carcinoma. Excision of the tumor, however, was preceded by choledochostomy by one month and cholecystogastrostomy became necessary nine months later. He was then comfortable for one and one-half years, at which time symptoms of obstruction at the pylorus necessitated posterior gastrojejunostomy. He lived eight months after this last operation. The third patient (Case 7, Table II) had undergone cholecystogastrostomy, in June, 1939, elsewhere for an indeterminate type of obstruction of the common bile duct. Nine months later transduodenal excision of adenocarcinoma grade 1

was done at the clinic and a new cholecystogastrostomy was made because the first one had failed to function. The patient returned to the clinic Nov. 1, 1941, with mild symptoms of pyloric obstruction. Roentgenographic examination showed slight obstruction of the second portion of the duodenum. Nov. 19, 1941, posterior gastroenterostomy was performed and exploration revealed obvious metastatic growth in the retroperitoneal nodes. Convalescence was satisfactory and the patient returned home. Death occurred two months later, two and one-half years after the first palliative procedure was done or nearly two years following excision of the tumor.

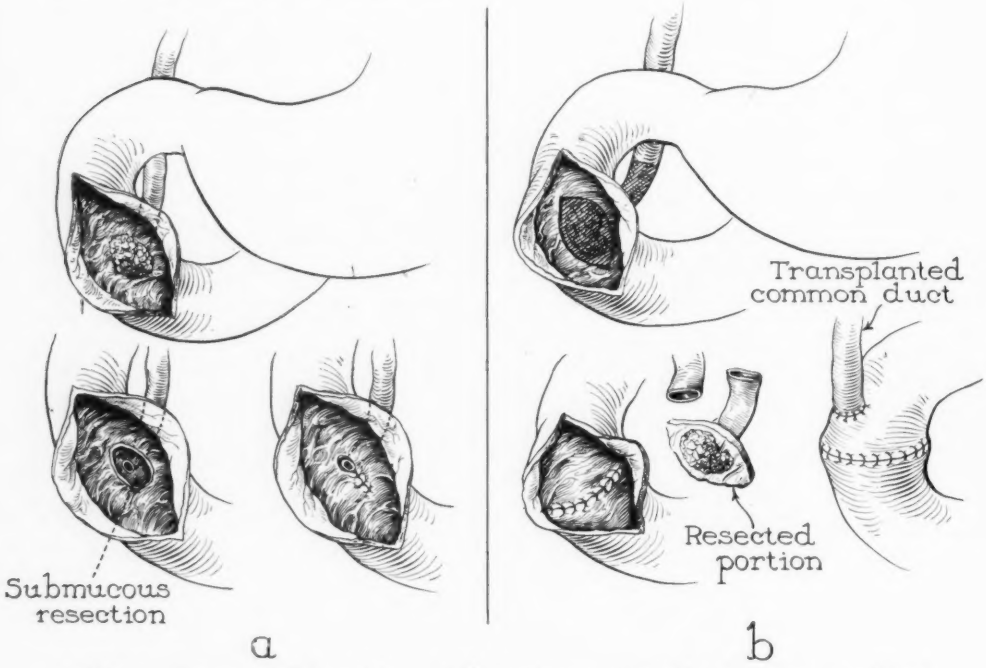

Fig. 6.—Transduodenal excision of the carcinoma of papilla of Vater; *a*, without disturbance of the continuity of the common ducts and duodenum; *b*, with transplantation of the common bile duct.

Resection.—Transduodenal resection for a tumor of some portion of the common duct and duodenum was performed in five cases and a modified Whipple operation was performed in two stages in one case (Table III). The patient who had the Whipple type operation succumbed to peritonitis only eight days after the second operation. Two of the five transduodenal resections were carried out in multiple stages, with one death. In the case in which death occurred (Case 2, Table II), cholecystostomy was done at the time of exploration for obstruction of the common duct of unknown cause. The tumor was noted at that time. Three months later transduodenal excision of the tumor together with resection of 1 inch (2.5 cm.) of common duct was carried out. Internal biliary drainage was instituted by choledochoduodenostomy over a Mayo

TABLE I

TYPES OF OPERATION AND MORTALITY

TYPES OF OPERATION	NUMBER	DEATHS	PER CENT
Resection for tumor:			
Transduodenal approach	8	3	37.5
Modified Whipple two-stage operation	1	1	100.0
Palliative operation:			
Origin of tumor proved by biopsy or necropsy	23	9	39.1
Origin of tumor conclusive in opinion of surgeon but not proved by biopsy	20	1	5.1
Exploratory only:			
Origin of tumor proved by biopsy or necropsy	3	3	100.0
Total	55		

tube. The patient died of peritonitis and hemorrhage two days later. Another patient (Case 8, Table II) had had cholecystectomy and choledochostomy in 1940. In six months, symptoms of obstruction of the common duct appeared and in fifteen months choledochostomy revealed the presence of the tumor. Six weeks later transduodenal excision of the tumor with resection of the lower end of the common bile duct and the cuff of the duodenum was performed. Choledochoduodenostomy was performed (Fig. 6*b*). The patient convaleseed well and lived for twelve months after the tumor was excised.

Two patients in this group were treated by a one-stage procedure without operative death. One of these (Case 3, Table II) had undergone cholecystectomy two months previous to the onset of jaundice. Secondary exploration revealed the tumor and it was resected transduodenally with a part of the common duct and choledochoduodenostomy was carried out over a Mayo tube. The patient lived twenty-six months, dying of recurrence of the tumor. Twenty-one months after resection of the tumor, exploration revealed the recurrence but no palliative operation could be carried out. The second patient (Case 5, Table II) lived nineteen months after transduodenal resection of the lower end of the common duct and posterior wall of the duodenum. Thirteen months after operation or six months before his death, exploration because of obstructive symptoms revealed the recurrent tumor from which he died.

In the last of the five cases of transduodenal resection (Case 6, Table II) a two-stage operative procedure was employed. It rather resembled a Whipple operation except that it was not so extensive. At the time of cholecystogastrostomy, the tumor was noted; this operation was followed in five months by transduodenal excision of the tumor, lower third of the common duct, a large portion of duodenal wall, and part of the head of the pancreas. The common duct was ligated permanently, internal biliary drainage being anticipated through the cholecystogastrostomy. Jejunostomy was carried out. The patient died in two days of peritonitis.

TABLE II

TRANSDUODENAL RESECTION OR EXCISION OF THE TUMOR

CASE	DATE	TYPE OF OPERATION	PATHOLOGIC FINDING	DURATION OF LIFE FROM REMOVAL OF TUMOR*
1	5/ 9/19	Transduodenal excision, common duct not severed from duodenum; cholecystoduodenostomy	Adenocarcinoma	8 days
2	12/29/21	Cholecystostomy; tumor noted	Adenocarcinoma	2 days
	3/24/22	Transduodenal resection with 1 inch of common duct; choledochoduodenostomy over Mayo tube; cholecystostomy		
3†	10/ 8/24	Cholecystectomy; tumor not noted	Colloid carcinoma	26 mo.
	1/10/25	Transduodenal resection of lower end of common duct; choledochoduodenostomy over a Mayo tube		
	9/20/26	Exploration for recurrence of carcinoma		
4†	11/ 1/28	Choledochostomy; biopsy	Carcinomatous polyp	35 mo.
	12/21/28	Transduodenal excision; plastic on common duct not necessary		
	9/ 9/29	Cholecystogastrostomy for recurring carcinoma		
	4/27/31	Posterior gastroenterostomy for recurrence of carcinoma		
5†	7/23/31	Transduodenal resection of lower end common duct and posterior wall of duodenum; choledochoduodenostomy over catheter	Adenocarcinoma, grade 2	19 mo.
	8/30/32	Exploration; recurrence of carcinoma		
6	7/13/37	Cholecystogastrostomy; tumor noted	Signet ring adenocarcinoma, grade 2	2 days
	2/10/38	Transduodenal resection of lower end of common duct, wall of duodenum, and part pancreas; common duct tied off permanently; jejunostomy		
7	6/39	Cholecystogastrostomy performed elsewhere	Adenocarcinoma, grade 1	22 mo.
	3/16/40	Transduodenal excision; common duct not severed. New cholecystogastrostomy		
	11/19/41	Exploration and posterior gastroenterostomy for recurrence of carcinoma		
8	6/24/40	Cholecystectomy; choledochostomy	Adenocarcinoma, grade 1	12 mo.
	9/11/41	Choledochostomy; tumor noted		
	10/22/41	Transduodenal resection for tumor, lower end of common duct; choledochoduodenostomy		

*Death had occurred in all cases.
†In Hunt's report.

Palliative Operations.—

Presence of tumor proved by biopsy or necropsy: In twenty-three cases biopsy or necropsy revealed carcinoma of the ampullar region and some type of palliative operation was performed (Table I). Nine-

TABLE III

TRANSDUODENAL RESECTION OR EXCISION OF CARCINOMA OF AMPULLA

TYPES OF OPERATION	TOTAL	SURVIVED	MORTALITY (PER CENT)	LONGEST SURVIVAL (MO.)*
Excision only, reimplantation common duct not necessary	3	2	33.33	
With establishment of internal biliary drainage	2	1	50	22
Without establishment of internal biliary drainage	1	1	0	35
Excision of tumor and resection of varying amounts of common duct and duodenum	6			
With reimplantation of common duct (multiple stages)	2	1	50	2
With reimplantation of common duct (one stage)	2	2	0	19 and 26
Common duct severed permanently and internal biliary drainage	1	0	100	
Modified Whipple operation, two stages	1	0	100	

*From time of removal of tumor to death.

teen of those patients were men. From one week to thirty months had elapsed between the onset of symptoms of obstruction of the common duct and any attempt at surgical treatment. These patients waited an average of 6.5 months after symptoms appeared before exploration. This is probably significant when compared with the shorter period of five and one-half months in those cases in which some type of removal of the tumor was possible. In most of these cases the patients were in such poor condition that one-stage removal of the lesion could not be attempted. In a few cases the palliative operation was considered as the first stage to subsequent removal of the tumor, but the patients did not return for the completion of the operation. In three cases there was evidence of metastatic growth at the time of the palliative operation. Nine of the twenty-three patients died in the hospital after the operation, a mortality rate of 39.1 per cent.

The types and frequency of palliative operations are listed in Table IV. Cholecystogastrostomy was used most frequently and was followed by a high mortality rate. These facts were emphasized by Judd and Hoerner[3] years ago. However, one patient lived forty-one months after palliative cholecystogastrostomy. Two had further operations, such as gastrojejunostomy, to relieve symptoms of obstruction at the outlet of the stomach. As a group, patients on whom cholecystogastrostomy was performed were in poorer condition than those on whom choledochostomy or choledochoduodenostomy was indicated. Cholecystostomy was performed five times with no deaths, but as would be expected, some further, more permanent operation to relieve obstruction of the common duct was required in all five cases. Choledochostomy or cholecystogastrostomy

TABLE IV

PALLIATIVE OPERATIONS: PRESENCE OF TUMOR PROVED BY BIOPSY OR NECROPSY

TYPE OF OPERATION	NUMBER	OPERATIVE DEATHS	MORTALITY (PER CENT)	FURTHER OPERATION NECESSARY	AVERAGE* LIFE (MO.)	LONGEST LIFE (MO.)
Cholecystogastrostomy	8	5	62.5	2	17	41
Choledochostomy	5	1	20.0	1	16	37†
Cholecystostomy	5	0		5	6	20
Cholecystostomy and choledochostomy	2	1	50.0	1		20
Choledochoduodenostomy	2	1	50.0	0		11
Cholecystogastrostomy and choledochostomy	1	1	100.0			
Total	23	9	39.1	9	13	41

*From time of first palliative operation to date of death (January, 1942).
†Patient living at time of inquiry.

seemed to be the operation of choice if, for some reason, removal of the tumor was impossible. Fourteen patients survived some form of palliative operation; all were traced and all but one had died at the time of the last inquiry (January, 1942); this patient was living thirty-seven months after choledochostomy. The average length of life (Table IV) following palliative operation for this disease was twelve and one-half months in this group of cases.

Presence of tumor not confirmed by biopsy: This group of twenty cases is included only for comparative purposes. No actual proof of the location of the lesion was obtained, but in every instance the surgeon stated definitely that in his opinion the tumor was in the ampulla of Vater. A diagnosis of carcinoma of the papilla was not made preoperatively. Seventeen of the twenty patients were men. Only one died in the hospital immediately after operation (Table I). The other nineteen were traced until Nov. 15, 1941, but only two were living. Cholecystogastrostomy was performed for fourteen of these patients and all survived the operation. Two were still living at the time of the last inquiry (January, 1942). The average postoperative duration of life of the twelve patients who had undergone cholecystogastrostomy and had died was fourteeen months. Cholecystostomy only was done in two cases; one patient died in the hospital after operation and one lived fifteen months. Cholecystoduodenostomy was provided in two cases, choledochostomy in one case, and cholecystostomy combined with choledochostomy in one case.

Exploration Only.—In three cases exploration only was carried out because of obstruction of the common duct of unknown origin. Biopsy in one case and necropsy in two cases proved the primary lesion to be in the region of the ampulla. All three patients succumbed within seven days after the operation.

COMMENT

Carcinoma of the papilla of Vater is not a rare disease, but early and correct clinical diagnosis of the presence of the lesion is unusual. Partly because of this but mostly because of the inaccessibility of the lesion, the usual poor condition of the patients, and the risk of radical surgical procedures, advance in the treatment of the disease has been discouragingly slow. The tumor is usually small, grows slowly, metastasizes late, and even the discerning eye can seldom detect early signs of its presence. Whether or not the prediction of the exact site of the lesion can be made accurately, obstruction to the common bile duct can be suspected early. Most obstructive symptoms attending carcinoma of the papilla will not yield to medical treatment, therefore, since correct preoperative diagnosis of ampullar lesions seems improbable, any patient who exhibits the signs and symptoms of obstruction of the common duct should be given the benefit of exploratory operation if the disturbances do not subside after the use of conservative measures for six to eight weeks. In most instances complete and permanent obstruction of the common bile duct does not occur as it frequently does in cases of carcinoma of the head of the pancreas. In fact, the growth may attain considerable size before complete obstruction of the duct occurs.

The technique of surgical treatment of lesions is rapidly being perfected. It can be applied equally well to carcinoma of the head of the pancreas, the common bile duct, or both. Until recently the best treatment seemed to be palliative procedures aimed at relief of the obstruction. Occasionally, transduodenal excision of the tumor or resection has been attempted, but the rarity of the attempt is attested by the fact that up to 1942 less than 125 cases have been reported in the literature. Recently Whipple revived interest by his two-stage operation and Trimble modified that procedure apparently with good results. Both of these procedures embody the principle of block resection for carcinoma. The gastrojejunostomy advised by both Whipple and Trimble forestalls the pyloric obstruction which is likely to develop if the patient survives for a reasonable length of time.

Although this study would indicate that at present simple palliative procedures anticipating both pyloric and biliary obstruction will offer as many months of comfortable living as any of the more radical operations, efforts to accomplish a cure by the use of the Whipple technique or some modification as suggested by Trimble must be encouraged.

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CHRONIC CONSTRICTIVE PERICARDITIS

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CHRONIC constrictive pericarditis, fortunately, is not a common disease. In the past, comparatively few surgeons have had the opportunity of operating upon patients with such a condition. In an analysis of 150 cases in which surgery was done, cited by Heuer and Stewart,[1] there were 49 operators, 27 of whom had operated upon only a single patient, 7 on two patients, 6 on three patients, and only 8 surgeons had operated upon five or more. Blalock and Burwell,[2] and Harrison and White,[3] to date have observed the largest number of cases in the United States, and also the greatest number brought to surgery—the former 28, with 20 patients subjected to surgery, and the latter 37, with 28 operated upon. Perusal of current literature dealing with this subject shows that only in a few of the larger medical centers has this condition received much attention. However, with increased interest in chest surgery in general and with a more widespread familiarity with the clinical picture of constrictive pericarditis, such cases are being recognized and brought to surgery, and in many cases most gratifying results have been obtained.

Every community has its quota of individuals suffering from this condition; individuals who are chronic invalids and who could be returned to a useful occupation and state of happiness if given a correct diagnosis and proper surgical intervention. It is with the idea of stimulating increased interest in this subject, particularly in localities apart from the larger medical centers, that this discussion is presented.

Chronic constrictive pericarditis is a condition brought about by an inflammatory lesion of the pericardium. It results in thickening and shrinking of the cardiac envelope, usually in association with a similar lesion in the epicardium, to the point where cardiac function is seriously interfered with. While there may be some interference with systole, due to myocardial involvement and adhesions, the primary dysfunction results from the inability of the heart to dilate adequately during diastole. This results in the heart being unable to receive enough blood to maintain an adequate arterial circulation.

Heuer and Stewart found in their group of patients that the arteriovenous oxygen difference was increased, the venous pressure was elevated, and the circulation time prolonged, while the cardiac output per

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minute, the stroke volume, and the cardiac index (cardiac output in liters per square meter of body surface per minute) was diminished.

As the inability of the heart to dilate increases with increasing constriction of the pericardium, or from actual constriction of the large veins at their passage through the pericardium, blood piles up in the vena cava causing increase in venous pressure which is normally negative in this location. Since most systemic veins have valves, the muscular action of the extremities assists in keeping the blood flowing

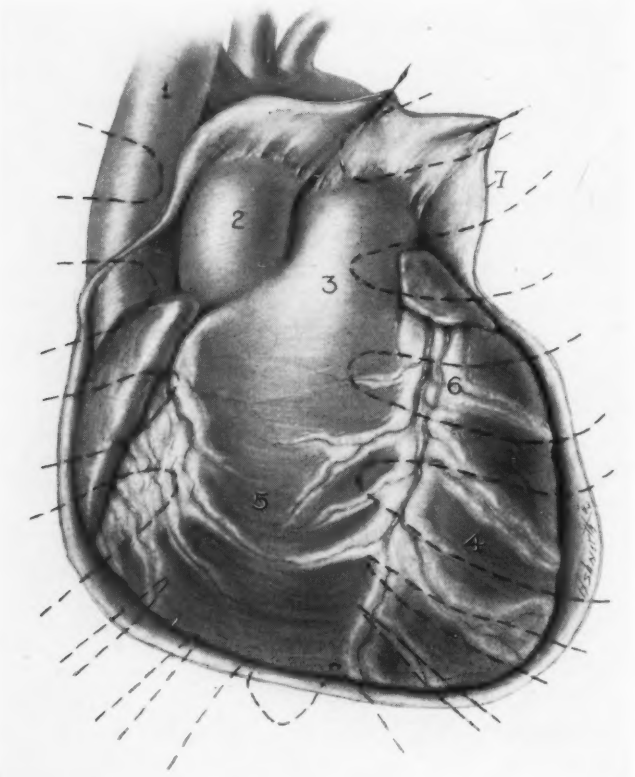

Fig. 1.—The normal anatomy of the heart. *1*, Superior vena cava; *2*, ascending aorta; *3*, conus arteriosus; *4*, left ventricle; *5*, right ventricle; *6*, anterior descending branch of superior coronary artery; and *7*, reflection of pericardium.

toward the heart and helps to account for the comparatively late development of edema in the lower extremities. The hepatic veins being without valves, the liver is one of the first organs to be affected by the abnormal venous circulation. The liver becomes congested, enlarged, and tender, and soon portal decompensation results as shown by the development of ascites. From continued insult, fatty degeneration of the liver may occur, and even fibrous replacement. This is one of the reasons why a long period of recovery, even lack of complete recovery, may follow when relief from cardiac constriction is brought about surgically. Later in the course of the disease pleural effusion may take place and edema of the lower extremities usually occurs.

Briefly then, the two changes in the dynamics of the circulation that are productive of symptoms and clinical findings are, first, the diminished ability of the heart to pump blood per beat and per minute and its inability to increase the output due to its inability to dilate, and, second, the increase in systemic venous pressure.

The name "Pick's disease" is commonly used to designate the condition of constrictive pericarditis, although White,[4] in a masterly discussion of this subject, points out that this condition was recognized long before Pick's time and that Galen, about A.D. 1600, described pericardial effusion in a monkey and scirrhous thickening in a cock, and surmised such an occurrence in man. White further states that Lower, in 1669, discussed this subject and should receive credit for the first satisfactory account of pericardial disease in man and the initiation of interest in the condition of acute and chronic constrictive pericarditis. Others contributing to the knowledge of the disease were Lancisi in 1728, Morgagni in 1761, and Laennec in 1818. At the end of the nineteenth century, namely in 1896, Pick emphasized the common finding of liver involvement and preponderant ascites, and so the disease has frequently been called by his name.

In the surgical consideration of this condition the names of Brauer, Delorme, Rehn, Sauerbruch, and Schmeiden, and in the United States Churchill, Heuer, Beck, Blalock, Cole, Bigger and others, have been intimately associated with the advancement of this means of therapy. Brauer, in 1898, advocated the resection of the chest wall over the region of the pericardium (the so-called operation of cardiolysis), and this operation was performed for him by Peterson, in 1902. The operation, naturally, has limited value and can be expected to be beneficial only in cases of attachment of the heart to the overlying chest wall. The modern operative procedure of pericardiectomy dates back to 1913 when both Rehn and Sauerbruch reported resection of the pericardium, although Delorme as early as 1895 had recommended this procedure. Churchill, in 1928, performed the first successful operation in America for the cure of this condition and since then a number of successful results have been reported from various clinics.

ETIOLOGY

The etiologic factor in the causation of constrictive pericarditis is variable, and even the commonest cause is not agreed upon. In Blalock and Burwell's series of cases the etiologic agent was established in 21 by aspiration, operation, or autopsy; 18 were found to be due to tuberculosis and 3 to *Staphylococcus aureus*. Such a preponderance of tuberculosis as an etiologic agent is not confirmed by other reports in the literature. Smith and Willius,[5] of the Mayo Clinic, found at autopsy 144 cases of chronic adherent pericarditis among 373 cases of pericardial disease; in 21.5 per cent the etiology was thought to be

due to rheumatic fever, in 17.4 per cent to pulmonary and pleural disease, 6.2 per cent to cardiac infarction, and 2.8 per cent to tuberculosis.

In 1934, Rothstein[6] collected all instances of adhesive pericarditis in children under 15 years of age who had been treated by operation. The number of cases was 34. Sixteen were thought to be due to rheumatic fever, 9 to tuberculosis, and 2 to pyogenic organisms. In Heuer and Stewart's 7 patients in whom surgery was done, only one case was proved to be due to tuberculosis.

White states that if rheumatism can cause Pick's disease it does so in only the rarest cases in contrast to the usually accepted origin. None of the 16 patients under observation at the Massachusetts General Hospital gave a history of rheumatism. He also refers to 1,000 children followed over a period of ten years at the House of the Good Samaritan in Boston. Not one developed constrictive pericarditis although in many, acute episodes of acute rheumatic pericarditis were noted. In a series of 37 cases studied by Harrison and White, the etiologic factor was found to be tuberculosis in 5, pneumonia in 2, sepsis in 1, and the etiology was unknown or questionable in 29.

The cause of the pericarditis in the two cases which we are presenting was not definitely established since no organisms were isolated from the tissue removed at operation and no diagnostic microscopic picture was present. Sepsis was suspected in one case, although tuberculosis could not be ruled out, and the other case may have resulted from a pneumococcus infection, although this is problematic.

CLINICAL FINDINGS

The symptoms and clinical findings in chronic constrictive pericarditis are fairly constant and lend themselves to differentiation from other conditions with which at times they may be confused. Bearing in mind the pathologic physiology of the circulation previously discussed, it is not difficult in most instances to interpret the clinical picture.

These individuals usually present well-marked evidence of circulatory embarrassment. Outstanding symptoms are generalized weakness, lessened work capacity, dyspnea on exertion (usually fairly promptly relieved by rest), congestion, discomfort about the face and neck, and swelling of the abdomen. Signs commonly present are venous congestions, as shown by distended arm, leg, and especially the neck veins. Cyanosis of varying degree is commonly noted, the liver is usually enlarged, at times markedly so, and varying degrees of ascites is usually present. Edema of the lower extremities and pleural effusion are less commonly found and splenomegaly is rarely associated. Venous pressure is constantly elevated. Readings of 20 to 30 cm. of water, which is about three times the normal, are usually found. This occurs without evidence of heart failure.

Physical examination reveals a small, or at most a moderately enlarged, heart. Some of the apparent enlargement may be due to thick-

ening of the pericardium. No evidence of valvular heart disease can be made out, although auricular fibrillation may be observed. The arterial pressure is low and the pulse pressure is small. Paradoxical pulse (a pulse that is thready in volume on inspiration) is commonly present. The normal circulation time is 15 to 20 seconds, and in the cases of constrictive pericarditis where this feature has been studied it has been found to vary between 30 and 60 seconds. Fluoroscopy yields additional valuable information. It confirms the physical finding of a small or moderately enlarged heart. Small or absent ventricular pulsation is usually noted. The presence of areas of calcification of the pericardium may be made out. The heart is usually "frozen" to its position and does not change with change in position of the patient. Roentgenographic studies in multiple positions will confirm the fluoroscopic findings and will demonstrate calcium deposits if they are present. Varying degrees of calcification of the pericardium have been noted in from 20 to 40 per cent of the cases studied. In 37 cases reported by Harrison and White the heart was found to be of normal size in 18 instances and moderately enlarged in 19. Roentgen kymography may add important information in the doubtful case of constrictive pericarditis.

Rigler, Wangensteen, and Friedell[7] have this to say about kymography in this disease: "Roentgenologic findings are of paramount importance, since they provide direct evidence of the cardiac impairment caused by pericardial scarring. Of the specific roentgenologic methods, roentgen kymography is probably of greatest merit since it deals directly with important changes in the physiology and dynamics of heart action. It is, therefore, admirably adapted to the study of cardiac impairment in constrictive pericarditis and it is possible that this roentgenologic procedure may become the most important single method in the diagnosis of this disease. In a general way it may be considered as a permanent record of that which may be observed on the fluoroscopic screen which is not only helpful in the diagnosis and progress of the disease but in estimating improvement following surgery."

The electrocardiographic changes associated with pericarditis have been discussed in some detail by Noth and Barnes.[8] The electrocardiographic pattern in constrictive pericarditis is fairly constant. Typically it shows low voltage of the QRS complexes in the three standard leads, and low voltage T waves, isoelectric or inverted in various leads.

Differential Diagnosis.—Cole and his coauthors[9] state that constrictive pericarditis is most often mistaken for congestive heart failure. Dyspnea is common to both conditions, but they point out that it is not relieved by rest and recumbent posture so much in heart failure as in pericarditis. Ascites develops early in constrictive pericarditis, usually preceding edema of the feet. This sequence is usually reversed

in congestive heart failure. The heart is small, or at most moderately enlarged, in constrictive pericarditis and usually is markedly enlarged in congestive heart failure. In failure of the heart, x-ray studies show congestion of the lung fields, while in constrictive pericarditis this is not found because the blood does not pile up in the auricles due to their inability to dilate. Murmurs or other evidence of underlying primary endocardial or myocardial disease are usually found in heart failure.

The individual with constrictive pericarditis usually has a history of long duration, and a similar amount of peripheral congestion, when due to congestive heart failure, takes place in a period of shorter duration in a much sicker patient. White lists, in the order of their importance, the things that are likely to cause confusion in the diagnosis of constrictive pericarditis.

1. Mitral stenosis
2. Polyserositis
3. Cirrhosis of the liver
4. Nutritional or other edema
5. Mediastinal tumors
6. Tricuspid valvular disease

He further states that mitral stenosis is accompanied by a characteristic diastolic murmur at the cardiac apex in the absence of severe active rheumatic infection, and that the presence of mitral stenosis may be taken at once as ruling out chronic constrictive pericarditis of any serious grade.

The finding of characteristic murmur, liver and venous pulsation, and change in heart contours is also important in the diagnosis of tricuspid heart disease.

In cirrhosis of the liver with ascites this organ is generally small, the individuals are usually in a later age group, and the characteristic findings of paradoxical pulse with low pulse pressure, distended jugular veins, and increase in venous pressure are absent.

Tuberculous peritonitis may have to be ruled out, although the characteristic findings of constrictive pericarditis are not present and the fluid examination shows it to be an exudate rather than a transudate. Evidence of pulmonary tuberculosis may be found in either condition.

Nutritional or other forms of edema are not usually associated with evidence of increased venous pressure. A therapeutic test with newer forms of parenteral vitamin and plasma protein therapy is quickly effective in eliminating these as causes.

Mediastinal tumors are readily differentiated by thorough roentgenographic study.

Prognosis.—What is the outlook for the individual with constrictive pericarditis with and without surgery? The consensus of all observers who have expressed themselves on this subject is that constrictive pericarditis is a progressively crippling disease. There is no medical cure, although by rest, diuretics, and removal of accumulated fluid in the abdomen or pleura, the individual may be temporarily improved. The disease tends to be chronic and is expected to last over a period of several to many years, although it has been known to kill the patient in months rather than years. Spontaneous apparent recoveries or periods of improvement may be explained by an acute phase subsiding by the absorption of pericardial fluid.

What does surgery have to offer? In Churchill's series of cases 6 patients were cured, 3 improved, 1 died on the fifth postoperative day, and 2 in which active tuberculosis was encountered died soon after operation. In a follow-up study of 37 cases by Harrison and White from the Massachusetts General Hospital, including those cited by Churchill, it is reported that 28 of the patients were operated upon. Of these, 14 were clinically cured, 3 were greatly improved, 5 died due to complications from the operation, 2 died primarily of the disease itself, and 4 died at varying times, postoperatively, of other complications. Nine of the patients were not operated upon. In 3 the condition was too mild, 3 were too sick, 1 died of miliary tuberculosis, 1 died before operation came into vogue, and 1 case was lost sight of. Of Schmeiden's 6 patients reported cured, 4 are well after 10, 12, 17, and 18 years. Heuer and Stewart reported 7 cases, with no deaths, 3 patients cured, 3 markedly improved, and 1 too early to determine the outcome. They were able to collect from the literature 143 cases in which the patients had been operated upon and 135 of these had been followed. Fifty or 37 per cent were cured, 31 or 23 per cent had been improved, 54 or 40 per cent died during or soon after operation. They comment, "At first glance this record of surgical results may not appear to be impressive, but in judging the results it should be appreciated that the disease is incapacitating and invariably fatal, and to have improved or cured 60 per cent of cases subjected to surgery is after all a real achievement."

Rigler and his co-workers say, "In this condition we have one of the few cardiac lesions for which there is at hand a specific therapeutic procedure, which in many cases without great risk, results in the transformation of a completely disabled individual into one who is, if not cured, at least competent to perform his daily tasks. In scarcely any phase of the brilliant accomplishments of thoracic surgery during the past decade are the results more dramatic or gratifying."

OPERATION

It is generally agreed that pericardiectomy should not be done during the active stage of the pericarditis. This seems to be particularly

true when the process is a tuberculous one. Pericarditis of nonrheumatic origin should be watched carefully for the onset of constrictive signs, as numerous cases have been cited where this sequence of events has been observed. Such individuals should not be subjected to surgery until the acute phase has had opportunity to subside; some suggest a period of six months to cool off, although each case should be individualized, and should not be neglected since the disease is usually progressive. With lapse of time the myocardium becomes weakened and the technique of the operation becomes more difficult.

Preoperative Preparation.—These individuals should have the abnormal accumulation of fluid in the tissues and serous cavities reduced to a minimum. Fluid in the pleural and abdominal cavities should be aspirated and that in the tissues reduced by diuretics and by limitation of fluid and salt intake. Mercupurin, 2 c.c. intravenously, every third day, limitation of fluids to 1200 or 1500 c.c. daily, and salt to 2 Gm. daily has been found of value. Intravenous fluids of all kinds such as saline, plasma, and blood are thought to be contraindicated preoperatively because of the edema and postoperatively to prevent undue strain on the decorticated myocardium. If the need postoperatively is great, small amounts of the fluids given slowly may be advisable. The use of digitalis, except in cases with auricular fibrillation, is usually contraindicated.

OPERATIVE TECHNIQUE

Position.—Most observers advise that the head of the operating table be elevated. This seems logical to help prevent venous engorgement. Churchill and others operate with the patient in a dental chair.

Anesthesia.—General anesthesia with differential pressure has distinct advantages because the pleura may be entered and positive pressure will prevent complete collapse of the lung and possible mediastinal shift. Nitrous oxide-oxygen ether mixture, ethylene, and cyclopropane have their advocates. The latter, in our experience with all types of chest surgery, has been most satisfactory. Intratracheal anesthesia is advised by many, although equally satisfactory results are obtained by a well-fitting mask and a closed system.

Incision.—The incision giving the best approach is a curved one, beginning in the region of the left second rib, carried down midsternally, and curved to the left over the sixth costal cartilage. (See Figs. 1 and 2.) The attachments of the pectoralis major muscle are separated from the edge of the sternum and costal cartilages. The third, fourth, fifth, and sixth costal cartilages and portions of the attached ribs are resected. It seems advisable to include the perichondrium if not the periosteum in order to prevent regeneration of the cartilage and thus allow subsequently greater freedom of cardiac movement. The flap consisting of skin, pectoralis major muscle, and intercostal muscle and vessels is turned back to the left as far as necessary to give adequate exposure. The inter-

nal mammary vessels are ligated at the upper and lower ends of the exposure. Approximately one-half of the sternum is usually resected, although Heuer finds this unnecessary. (See Fig. 3.) The edge of the pleura can now be identified and wiped back, frequently resulting in an opening being made through this structure. This is of little consequence and the opening may be sutured or covered over with a moist pad. In fact, some observers advise leaving an opening into the pleura in non-infected cases to allow greater diffusion of any postoperative pericardial fluid. The stage has now been set for an attack on the pericardium. This may be an exceedingly simple procedure if the pericardium is calcified and not attached to the epicardium or it may be a very difficult, tedious, and dangerous task if the pericardium is densely adherent to the epicardium and the lines of cleavage difficult or impossible to identify. Each classification is represented by the two cases we are reporting.

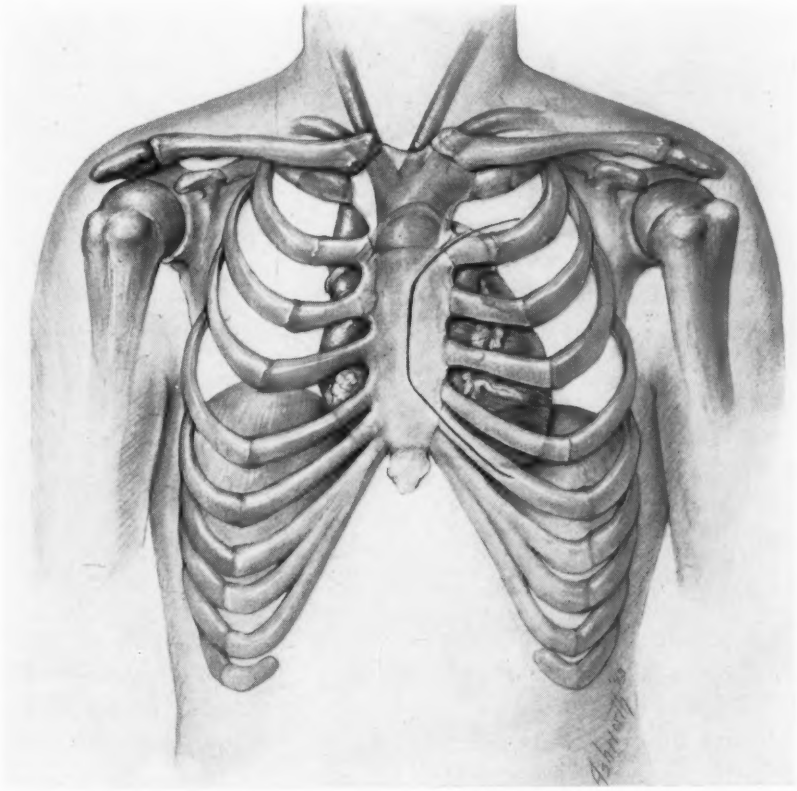

Fig. 2.—The relationship of the incision to the bony cage and underlying structures.

Certain principles governing the removal of the constricting capsule of the heart seem fairly universally agreed upon. First, that extreme care should be used to prevent injury to the anterior descending branch of the left coronary artery lying in the groove between the right and left ventricles. Second, that the left ventricle should be uncovered first.

Its musculature is thick and there is less likelihood of entering the cavity of the heart than elsewhere. Also, if the right ventricle is freed first, more blood will be permitted to enter the lung and this, coupled with lack of support to the heart muscle, may allow the ventricle to dilate, resulting in acute pulmonary edema and cardiac failure. It should be remembered that the greater part of the heart presenting anteriorly is the right ventricle and that the left ventricle lies well to the left and behind. (See Fig. 4.) Third, it is a dangerous procedure and in most instances it is unnecessary to attempt to free the auricles and the great vessels to and from the heart. Their walls are thin and easily penetrated. Fourth, it is necessary to remove not only the pericardium but usually also the epicardium to free the heart. Frequently no line of cleavage exists between these two structures. Fifth, when removing the constricting fibrous tissue it is well, as first pointed out by Bigger,[10] to leave one side attached during the dissection so it can be used as a flap to cover over the area in case the heart cavity is accidentally penetrated.

The extent to which decortication should be carried out is undecided and each case presents its own individual problem. It seems desirable to free as much of both right and left ventricles as can be done with safety, and particularly to free the apex of the heart, which is usually adherent to the diaphragm. It is advisable to give the heart periods of rest during the operation. Frequently the action of the heart becomes irregular and rest of a minute or two will allow it to resume its normal pace. If the patient is in poor physical condition, and frequently such patients are, especially if the nature of their illness has been long unrecognized, and the dissection is time-consuming, it may be advisable to do the operation in stages as was necessary in one of our cases. It may even be advisable, at a subsequent time, to decorticate the right side of the heart through an incision to the right of the sternum similar to the one previously described on the left side.

Little suture material is needed in this operation except for control of hemorrhage in the flap and during the closure. In one of our cases we used silk and in the other cotton. In both instances the operative field was lightly dusted with sulfanilamide powder. Whether or not this is advisable is questionable since the use of this powder in operative wounds elsewhere undoubtedly increases the amount of serum.

Cole advises draining the pericardial area by use of a small rubber drain in the upper or lower end of the incision. Postoperative aspiration, if necessary, would seem advisable rather than drainage as a procedure less likely to result in infection. One of our patients was aspirated, the other was not; neither was drained. It apparently is an infrequent occurrence for cardiac embarrassment to result from tamponade after pericardiectomy because the fluid is no longer encased in a nonelastic sac but can diffuse into the tissues of the chest wall and usually into the mediastinum.

Postoperatively.—These patients are usually benefited by inhalations of oxygen—by tent, mask, or catheter—by the use of morphine and sedatives, and by methods that were of value preoperatively, such as limitation of fluids and salt, and by aspiration of fluid from serous cavities.

CASE REPORTS

CASE 1 (Queen's Hospital No. 153811).—A Caucasian man, aged 41 years, was admitted March 31, 1942, and discharged April 16, 1942. About one and one-half years before admission to the hospital he began noticing a sense of fullness and flushing of the face, neck, and head, especially after eating, leaning over, or when lifting up objects. He developed shortness of breath when running upstairs and indulging in other exercises, but this had never been marked. He perspired more than he did formerly and had noticed swelling of the ankles, especially the right

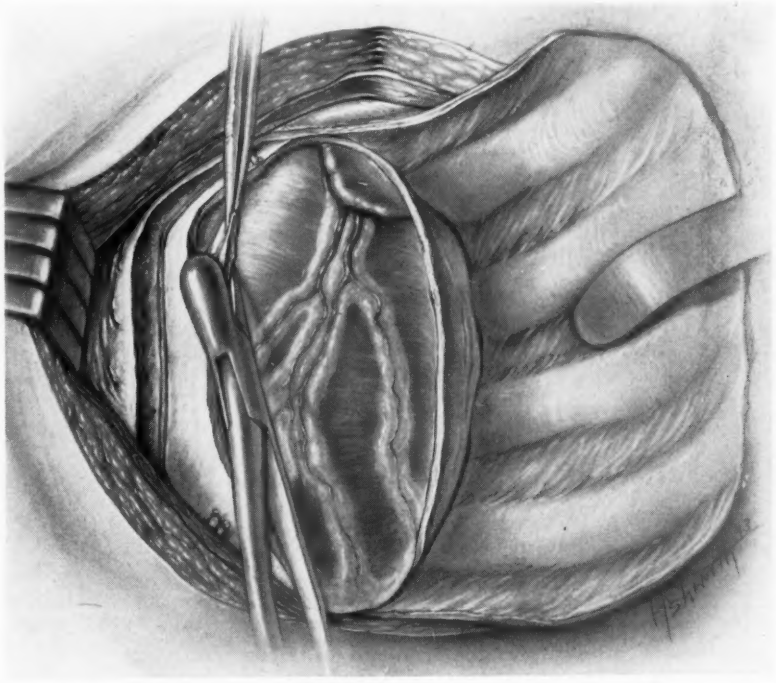

Fig. 3 (Case 1).—Exposure of pericardium showing ease of removal of calcified pericardium when unattached to the epicardium.

one, for the past four months. The left one was swollen also, but not as much as the right. There had been increasing leg varicosities for a longer period. Past history was essentially negative except for an illness of serious consequence in 1937. He was told, in 1915, that he should give up swimming because he had some trouble with his heart. He did not, however, cut down on physical activity and suffered no apparent ill effects. In January, 1937, a coral cut on the right foot became infected and lymphangitis and inguinal adenitis quickly developed with associated fever and malaise. Soon after this he developed what appears to have been a metastatic infectious arthritis involving the right wrist and phalangeal joint of the middle finger of the left hand. There has been permanent deformity of these joints since. The patient remembers that he had to sit up for a few nights during the illness because

of suffocation on lying down. The entire episode lasted about four months. There was a positive family history of tuberculosis. One brother was treated in a sanatorium after he reached adult life. Contact with this brother was infrequent.

For the past six months the patient had noticed some distention of the abdomen. His weight had increased ten pounds but his friends remarked that his face was thin. There was slight distress in the cardiac area but he had never had pain of any severity. The last four or five years when his bed came up close to the wall he noticed that it bumped against the wall with each heart beat, making him think that he must have very strong cardiac pulsations. For the past few months he had been extremely tired and had not been able to do his daily tasks. He found that he rode where he formerly walked. He also complained of loss of sexual desire.

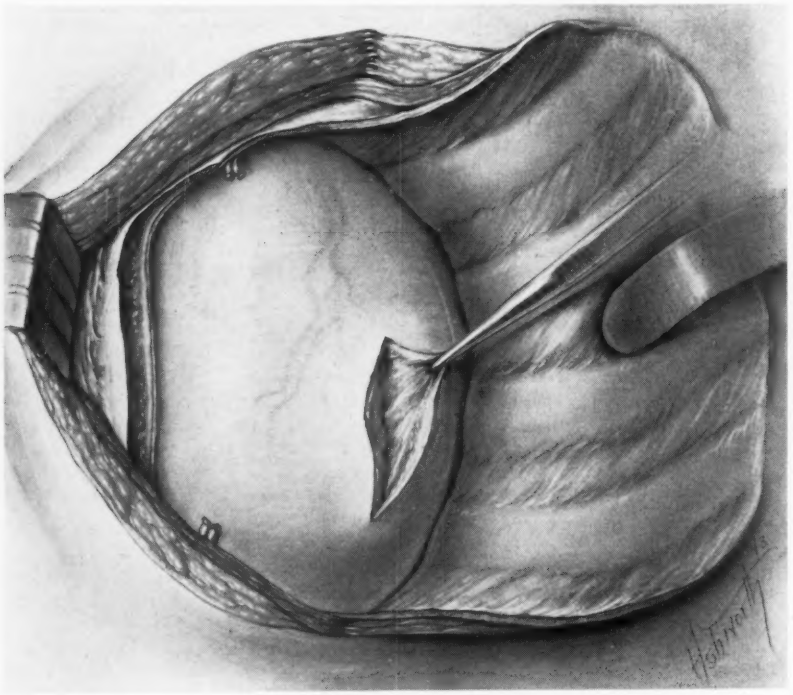

Fig. 4 (Case 2).—Pericardium and epicardium densely united to one another making removal a slow, tedious, and dangerous procedure.

Examination showed congestion of the face when lying down and pulsation of the jugular veins. There was slight cyanosis of lips and nail beds. The veins in the arms were prominent and there were rather marked varicosities in both legs. There was edema in both ankles, especially the right. The abdomen was distended and all signs of fluid were present. The liver was palpable four fingerbreadths below the right costal margin, and somewhat nodular. The pulse was regular and no paradoxical tendency was noted. Rectal examination was negative. Blood pressure was 116/70. Heart examination showed the point of maximum impulse just outside of the midclavicular line. Apex beat was somewhat increased in force but sharply circumscribed. A split second sound was heard at the apex (confirmed by stethogram). On fluoroscopy the heart was not enlarged and the amplitude of pulsation was diminished. X-ray of the chest showed large hilar shadows with calcified areas and a small bilateral pleural effusion. The pericardium was calcified practically in its entirety. This was especially well seen in the lateral and oblique positions.

Electrocardiogram showed small QRS complex in three standard leads. T waves were of low amplitude throughout, being flat in the first lead and inverted in Leads II and III. Urine was negative, red cell count 3.95 million, white cell count 8,800, polymorphonuclears 49 per cent, small lymphocytes 40 per cent, monocytes 8 per cent, eosinophiles 3 per cent. Icterus index was 23, van den Bergh delayed direct reaction 16.6 mg. per 1000 c.c. of serum, Weltmann coagulation test, coagulation 1, 6 tubes normal. Sedimentation rate was 3.3 per cent; plasma protein 4.55 Gm. per 100 c.c. of blood; direct venous pressure on March 11, 1942, right arm 26 cm., left arm 22 cm., right leg 18 cm., left leg 23 cm. On April 1, 1942, 1200 c.c. of straw-colored fluid was aspirated from the abdomen. Culture was sterile. On April 2, 1942, the patient was given 500 c.c. of plasma with 100 c.c. saline solution.

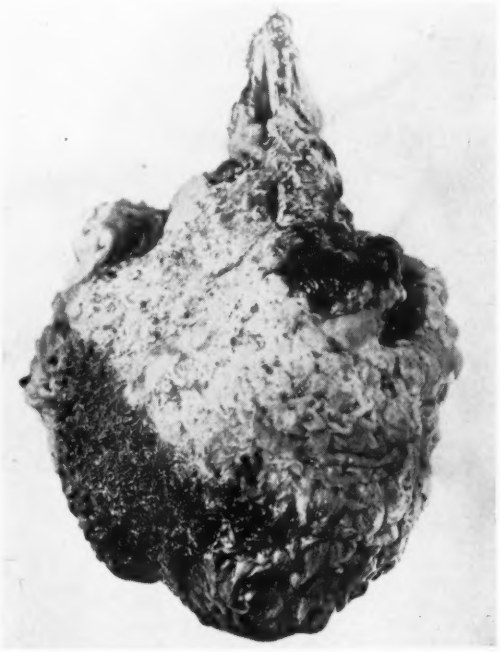

Fig. 5.—Autopsy specimen showing reaction about heart following pericarditis complicating influenza. It is easy to see how such a reaction might be followed by constrictive pericarditis.

Operation.—Operation was done April 3, 1942, with cyclopropane anesthesia, differential pressure. The head of the table was raised to an angle of 30 degrees. An incision over the front of the chest was made as shown in Fig. 2. The attachments of the pectoralis major muscle were freed and reflected. The third, fourth, fifth, and sixth costal cartilages with the perichondrium were removed, and portions of the fourth and fifth ribs were resected subperiosteally. The left pleura was carefully wiped back to the region of the left phrenic nerve. The mammary vessels were ligated and divided at the upper and lower margins of the exposure. This gave an excellent view of the calcified pericardium. It gave the appearance of a large china egg deposited behind the sternum. No cardiac pulsation was visible and as far as could be determined the entire pericardium had become calcified except the outer layer which was quite thin but tough and fibrous. The underlying calcium was easily broken through and consisted of two very thin layers. In no place was it attached to the epicardium. It shelled off with almost as much ease as one might experience in peeling an onion. The underlying heart looked normal and protruded

out through the undecked area as though being released from considerable compression. The left ventricle was freed first. The anterior descending branch of the left coronary artery was easily identified and protected. The left auricle and the region of the conus arteriosus were freed without difficulty as were the apex of the heart and the right ventricle and auricle as far as could be reached beneath the sternum. During the operation some irregularity of heart action occurred but not to a significant degree, probably because the heart itself was handled very little. A small opening was made in the left pleura. This was covered with a moist pad and no effort was made to close it. Sufficient positive pressure in the anesthetic system was used to prevent cardiorespiratory embarrassment. The bleeding points were carefully ligated. The operative field was lightly dusted with sulfanilamide powder and the incision was closed tight. Interrupted silk was used throughout.

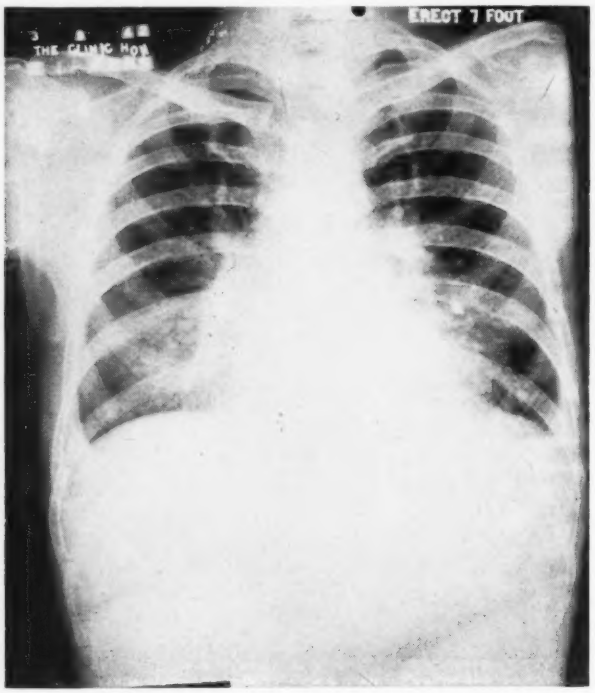

Fig. 6 (Case 1).—Roentgenogram of chest showing calcified left hilum gland, congestion of both hila and bases, and a small puddle of fluid in the costophrenic sulcus bilateral. Heart shadow is normal size.

Postoperative Course.—The patient was given nasal oxygen and morphine, gr. 1/6, as needed. He was given one intravenous injection of 500 c.c. of 5 per cent glucose in lactate Ringer's solution. On the third postoperative day a friction rub was heard in the left axilla, and on the fifth postoperative day 1500 c.c. of serosanguineous fluid was aspirated from the left chest followed by air replacement. On the twelfth postoperative day the venous pressure in the right arm was 12.5 cm. and in the left 11.3 cm. The patient made a good recovery and was discharged from the hospital on the thirteenth postoperative day.

One year after the operation the patient stated that as far as he could tell, he felt practically well. Slight congestion of the neck and face appeared when he lay down. Varicosities of the legs were present although much less marked than formerly. Slight ankle edema appeared at the end of the day. Liver was palpable

about two fingerbreadths below the right costal margin. Venous pressures were 14 cm. Electrocardiogram showed little change from the previous tracing.

CASE 2.—A Filipino girl, aged 9 years, was admitted to Leahi Hospital, March 22, 1939. She had always been emaciated and sickly. She had pneumonia at the age of 18 months and was hospitalized for three months at the age of 7 years with a diagnosis of malnutrition. In January, 1939, she had been admitted to Aiea Hospital with the diagnosis of pneumonia.

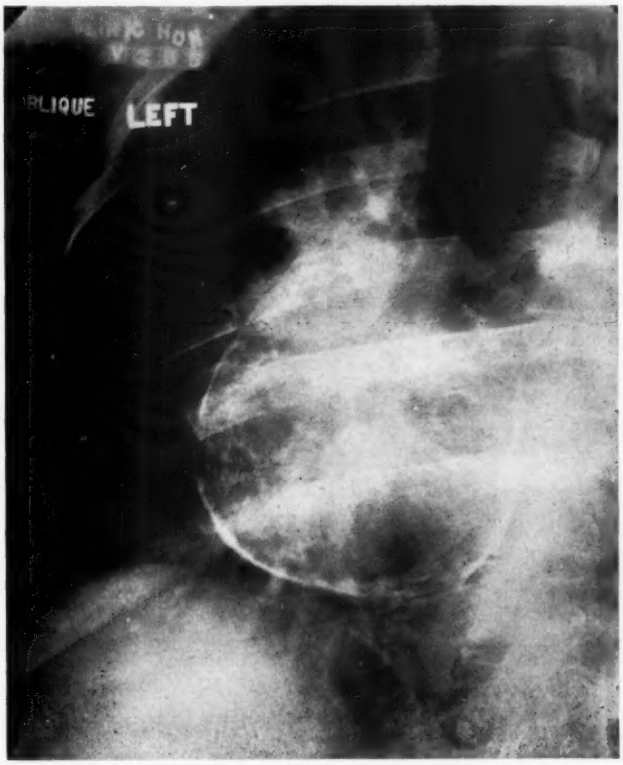

Fig. 7 (Case 1).—Oblique view of chest showing calcification of pericardium.

Examination revealed an emaciated, poorly developed girl. The jugular veins were prominent and pulsated. There was dullness on percussion and absence of breath sounds over the lower part of both chests. The abdomen was prominent and the liver edge was palpable three fingerbreadths below the costal margin. The spleen was not palpable. Blood pressure on admission was 78 systolic and 60 diastolic. The Mantoux test was negative on second strength purified protein derivative and up through 1.0 mg. of old tuberculin. Eagle and Kahn tests were negative. Serum protein was 7.1 mg. per cent, blood sugar 93 mg. per cent, blood cholesterol 138.9 mg. per cent, nonprotein nitrogen 28 mg. per cent, and urine negative.

X-ray of the chest on admission showed more bilateral pleural fluid on right side than on the left. The cardiac outline at the time was obscured but later studies after thoracentesis showed it not to be enlarged. No calcification of the pericardium could be seen. Fluoroscopic studies showed very little cardiac pulsation. Venous pressure averaged around 30 cm. of water. Electrocardiogram showed right axis deviation.

Between the time of admission, March 22, 1939, and July 29, 1942, at which time the first stage pericardiectomy was done, the right chest was tapped eight times and 3300 c.c. of fluid were removed; the left chest was tapped three times with 475 c.c. of fluid, and the abdomen five times with 30,075 c.c. of fluid removed. In addition to removal of fluid by aspiration the patient was given theophylline and

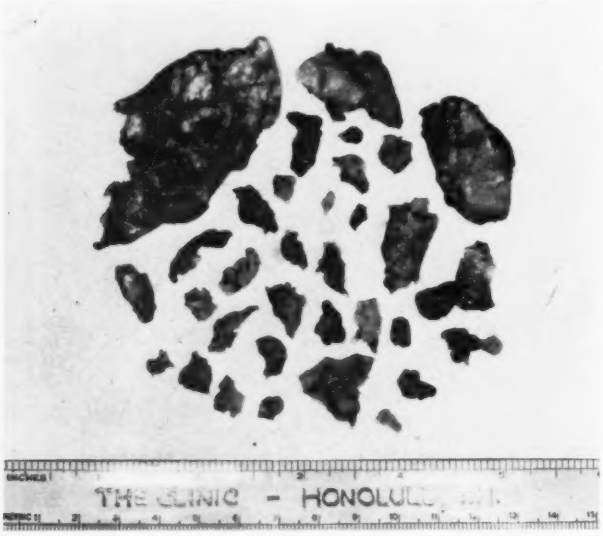

Fig. 8 (Case 1).—Portions of calcium removed at operation.

Fig. 9 (Case 1).—The incision.

salyrgan, 1 c.c. intravenously, about two or three times a week. She was also given enseals of ammonium chloride, 15 gr. daily. Response to these drugs was good as noted by the increase in urinary output but as was to be expected the effects were temporary.

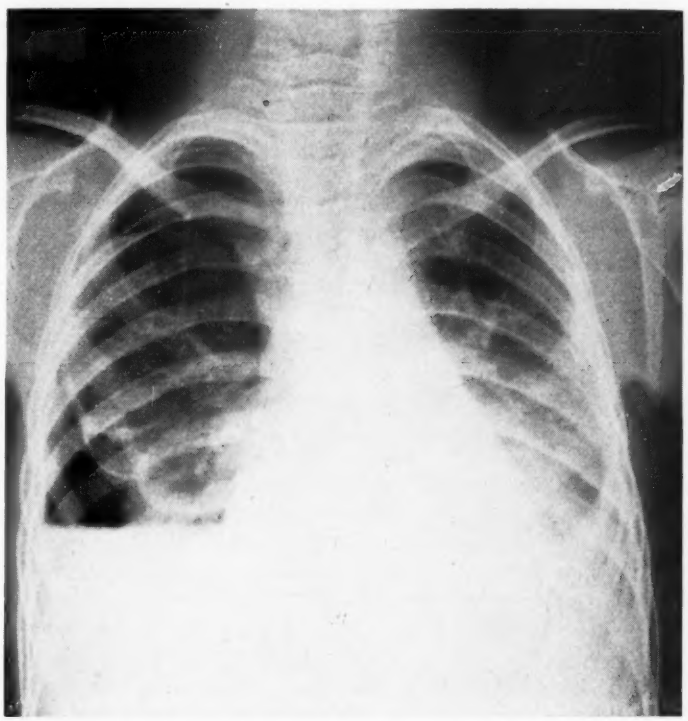

Fig. 10 (Case 2).—Normal sized heart with bilateral pleural fluid. Hydropneumothorax on the right side.

Fig. 11 (Case 2).—The patient and incision.

Operation.—The first stage was done July 29, 1942, under cyclopropane anesthesia. The incision and exposure of the pericardium parallel that described in Case 1. The pericardium was greatly thickened and densely adherent to the heart, there being no line of cleavage in most places between the peri- and epicardium. (See Fig. 4.) Over the left ventricle a pocket containing 5 or 6 ounces of straw-colored fluid was encountered lying between the peri- and epicardium. This gave a starting point for subsequent dissection. The apex of the heart was found densely adherent to the central part of the diaphragm by a broad adhesion. This was resected. No calcium was encountered during the operation. A considerable amount of thickened pericardium overlying the right and left ventricles was removed but not as much as was needed to free the myocardium adequately. Operation was discontinued because it was felt that we were dealing with a poor operative risk and it seemed advisable to divide the operation into stages.

Following the first operation there was some clinical improvement but this was not marked. The patient seemed less cyanotic, the veins in the neck were perhaps less prominent. The abdomen was tapped on Aug. 26, 1942, and 4500 c.c. of fluid were removed.

The second stage of the operation was done on Sept. 9, 1942. The previous incision was opened, the second rib was resected and the third and fourth removed farther back to give better exposure. The operation consisted largely of removing the thickened epicardium which had been left at the previous time. This was carried out particularly over the right and left ventricles and to some extent in the region of the auricles. The undecked muscle expanded significantly, giving much freer heart action in systole and diastole. It was felt that a very definite and marked release of the heart from its tightly constricting envelope had been accomplished. The pulse pressure during the operation increased from 20 to 40 mm. of mercury.

Postoperative Course.—The patient made a good recovery. On the fourth postoperative day the precordial area became prominent and 100 c.c. of bloody fluid were aspirated. Following the second operation the patient made considerable clinical improvement but the results, in August, 1942, did not come up to expectations. The right chest was aspirated on Nov. 4, 1942, and 200 c.c. of fluid removed, and 75 c.c. again on March 20, 1943. The abdomen was aspirated three times: on Oct. 7, 1942, 3450 c.c. were removed, on Jan. 16, 1943, 4200 c.c., and on March 24, 1943, 3300 c.c.

The venous pressure remained elevated although the blood pressure returned to normal limits. Whether the lack of more improvement was due to permanent fibrous changes in the organs outside the heart or whether the heart and great vessels needed further release from constriction is an open question. It is probable that a third operative effort should be made by an approach to the right of the sternum unless more improvement takes place within a few months.

SUMMARY

A review of the pathologic physiology, the diagnosis and surgical treatment of constrictive pericarditis, and a report of two cases treated surgically is presented.

In concluding this discussion of chronic constrictive pericarditis, we wish to emphasize the cardinal findings in this disease. The heart is normal in size, or only moderately enlarged; it is in a fixed position; little or no evidence of pulsation can be elicited by physical or fluoroscopic examination; the peripheral veins are prominent, particularly the external jugulars; the venous pressure is high and the systolic blood pressure and pulse pressure are low. The liver is enlarged and generally

associated with abdominal ascites; there may be fluid in the pleural spaces, and edema of the lower extremities. The signs of passive congestion of the lungs are conspicuous by their absence.

It has not been our purpose in writing this article to attempt to present anything new, for this has not been done. Rather it has been our aim, as stated in the beginning, to help stimulate interest in this subject in faraway places where such conditions do exist and where such individuals cannot avail themselves of the diagnostic and surgical skill of the large medical centers.

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RECURRENT POSTOPERATIVE ATELECTASIS

Report of a Case

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CASES of recurrent postoperative atelectasis have been reported by Scott and Joelson,[1] by Farris,[2] and by Apfelbach and Carter.[3] Their cases occurred at operations two and one-half, two and eight months apart, respectively. The first two occurred following abdominal operations and the last following a two-stage Torek procedure. We wish to report this case of recurrent postoperative atelectasis occurring in a 57-year-old woman who underwent two breast operations in six days, both of which were followed by atelectasis on the right side.

Case Report.—Mrs. L. G., a 57-year-old widow, was admitted to the surgical service of the Rochester Municipal and Strong Memorial Hospitals on Feb. 23, 1943, with the chief complaint of having had a lump in her left breast for one month. She complained of a burning type of pain in her breast and had lost about seventeen pounds in weight in the last few months. She had noted no enlargement of her breast or bleeding from the nipple. Past history was interesting in that she had had four operations in this hospital. In 1933 she had a gastrojejunostomy for duodenal ulcer under avertin and gas-oxygen on April 4; on August 26, she had a right lobectomy of her thyroid for toxic nodular goiter under gas-oxygen-ether; and on November 19, had a dilatation and curettage, amputation of the cervix, and radical cure of cystocele and rectocele under ether. On Feb. 7, 1935, she had a dilatation and curettage for cervical stenosis under gas-oxygen. All these procedures were well tolerated without postoperative sequelae.

At the time of these procedures she had had no cardiorespiratory symptoms. With the present admission she had a history of exertional dyspnea, swelling of her ankles, and two pillow orthopnea of one to two years' duration. She had not taken digitalis for five years which she started in 1935 because of symptoms of angina pectoris and evidence of mild decompensation.

General physical examination revealed a well-developed and well-nourished 57-year-old white woman in no acute distress. The heart was enlarged to the right and left. There were no thrusts or thrills. Sounds were regular, of poor quality without murmurs. Pulses were equal without deficit. Lungs were clear to percussion and auscultation. Extremities showed slight pitting edema. Vessels showed moderate arteriosclerosis. In the outer upper quadrant of the left breast there was a rounded firm mass, freely movable, about the size of a cherry (2 by 2 cm.). There was no retraction of the skin. No axillary or supraclavicular glands were palpable. No masses were noted in the right breast. The abdomen was soft and no masses were felt. The liver edge was not palpable. Pelvic examination revealed a healthy amputated stump and a two degree retroversion of the uterus. Numerous telangiectases were present over the body.

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X-ray examination of the chest revealed slight left ventricular hypertrophy, a tortuous aorta, clear costophrenic angles, and essentially normal lung fields. There was no evidence of metastasis. Laboratory findings: white blood cell count, 7,400; hemoglobin, 14.8 Gm.; urine, negative; Wassermann, negative.

On Feb. 24, 1943, the patient was taken to the operating room and biopsy of the nodule of the left breast carried out under gas-oxygen-ether anesthesia. Duration of the anesthesia was fifty minutes in all. Operating time was ten minutes. Preoperative medication was .010 morphine sulfate and .0003 atropine sulfate. Frozen sections were not definite and it was decided to close the wound and wait a few days for further study of the sections. The patient was sent to the recovery room where specially trained nurses are in charge of the patients until they respond and are returned to the divisions. The patient responded and was returned to her division. The nurse reported her condition satisfactory at 12:15 P.M. At 1:15 P.M. the patient showed diffuse cyanosis and failed to respond. Respirations were slow and shallow. Examination revealed the trachea to be shifted to the right. Breath sounds were depressed at the right base with some sticky inspiratory râles. Percussion of the chest revealed the mediastinum to be shifted to the right. Breath sounds were normal on the left. A diagnosis of acute atelectasis on the right was made. Preparations were made for immediate bronchoscopy. Oxygen was given because the interval before this was carried out with some decrease in her cyanosis.

Bronchoscopy was carried out using a No. 7 Israel scope and the bedside technique as advocated by Tucker, referred to by Lell.[5] Several large plugs of mucus were removed from the trachea and the right main bronchus. The mucosa appeared edematous. The patient's cyanosis disappeared almost immediately. Breath sounds were evident on the right side by auscultation and the trachea shifted back to the midline. The patient responded well and her only complaint was a slight sore throat. She was started on sulfadiazine by hypodermoclysis prophylactically. Her temperature that afternoon at 4 P.M. was 37.8° C. by mouth and from then on never rose above 37.5° C. Her convalescence from this experience was uneventful. At no time did she develop any cough or sputum.

Pathologic report was returned, papillary cystadenocarcinoma of the breast. Radical mastectomy was indicated and on March 1, 1943, the fifth postoperative day, this was carried out under gas-oxygen-ether. Operating time was two hours. Anesthesia time was two hours and thirty-five minutes. Preparation medication consisted of .016 morphine sulfate and .0003 atropine sulfate. Because of our previous experience with this patient, intratracheal anesthesia was used and suction of the trachea carried out for the final twenty minutes of the operation, the upper respiratory tract and trachea being cleaned of all mucus. Operation was completed at 11:10 A.M. She was sent to the recovery room. At 11:50 A.M. the patient became diffusely cyanotic and had depression of respirations to 8 per minute. Examination revealed essentially the same findings as followed the first operation. The trachea was shifted to the right. Breath sounds were depressed on the right side and there was mediastinal shift to the right. She was given intravenous coramine and bronchoscopy was carried out. This time the right middle and right lower lobe bronchi were found to be occluded by mucus plugs and these were sucked out. The mucosa appeared red and edematous but the trachea was clear. The patient responded immediately and her cyanosis disappeared. Breath sounds were well heard at the right base.

The patient was not started on prophylactic sulfonamide therapy this time. The day following her operation she had a temperature elevation to 38.2° C. There was some depression of breath sounds at the right base and a few sticky

inspiratory râles were present. A diagnosis of residual peripheral atelectasis was made. Sulfadiazine therapy was started. Temperature elevations continued for the next two days to 38.0° C., but she had no cough or expectoration. The remainder of her postoperative course was essentially uneventful. She was discharged home on the sixteenth postoperative day. No x-ray examination of the chest was done after the first acute atelectasis. Two days after her second atelectasis a roentgenogram revealed no evidence of a pneumonic or atelectasis process in the lung fields.

DISCUSSION

The possibilities of the cause of atelectasis in this patient who ten years before had undergone general anesthesia three times, and eight years before once, three of these being major procedures, are manifold. With her present operation this patient now a cardiac, Class III, and with evidence of mild failure might well fit into that class suggested by the vasomotor theory. This theory suggests the possibility of dilatation and stasis in the blood vessels producing obstruction by the outpouring of secretions. The importance of obstructing bronchial secretions was first stressed by Elliott and Dingley[10] and emphasized by Jackson and Lee.[11] The mucous membranes in this case were edematous and the patient at no time had retched or vomited. There were definite plugs which were occluding the bronchi and which were aspirated at the time of bronchoscopy. The patient had received .0003 Gm. of atropine preoperatively both times and the possibility of this drying up the secretions into tenacious mucus plugs must be considered. We believe that .0003 Gm. of atropine is the minimal amount a patient should receive preoperatively who is going to have a general inhalation anesthesia. This vasomotor theory is mentioned by Mousel,[4] who later states that he believes most postoperative atelectasis is caused by an actual plugging of the bronchus, tenacious mucus secretion which has collected in the tracheobronchial tree during anesthesia, by tenacious mucopurulent material present preoperatively, or by mucus, blood, or vomitus which has been aspirated into the bronchus either during or immediately following the anesthesia. We believe that this patient might well fit into the first group.

William Lell[5] mentions as one of his six modus operandi of postoperative atelectasis "the too frequent improper and often unnecessary use of intratracheal anesthesia." He believes that the presence of a large catheter in the glottis of the larynx prevents the vocal cords from approximating and secretions can thus be readily aspirated into the tracheobronchial tree. We did not use it in the first operation. In the second it was used in order that the tracheobronchial tree might be thoroughly aspirated postoperatively. While it might have been a contributing cause to atelectasis in the second operation, this experience does bring out an important point, namely, that even after twenty minutes of assiduous suction by a trained anesthetist, a catheter suc-

tion cannot be effective beyond the bifurcation of the trachea. This was confirmed at bronchoscopy when the trachea was found to be clear but there were two plugs occluding the right lower and middle lobe bronchus.

The suddenness with which these attacks of atelectasis occurred following operation is interesting. Zukschwerdt and Lezius[6] state that postoperative massive collapse of the lung never appears before the second or after the fifth postoperative day. These cases of proved postoperative massive collapse following within three and one-half hours and forty minutes, postoperatively, are contrary to this broad statement as well as cases reported by Gius,[7] and the extremes stated by Adams,[8] who says that it characteristically makes its appearance twenty-four to seventy-two hours following surgery, but may develop as late as seven to ten days postoperatively. These instances are believed to have occurred in the shortest time interval postoperatively yet reported.

Thomas and his co-workers[9] in a discussion on massive collapse of the lung as a complication of surgical procedures mentions as the first important point, postoperatively, the bandaging of the patient. Following the first operation the patient had only a local dry sterile dressing applied to the biopsy wound. There was no restriction to movement of the chest or abdomen by bandaging. After radical mastectomy a large compression bandage was applied to the chest to prevent fluid exudation into the dead space formed by removal of the breast. This did restrict motion of the chest, which in a female predominately a costal breather is an important factor. While a factor in the second instance it was not present in the first attack.

SUMMARY

1. A case of recurrent atelectasis is reported following biopsy of the left breast and five days later radical removal of the left breast.

2. Both instances occurred on the right side; the first involving the right lower lobe and the second the right lower and right middle lobe.

3. Mild cardiac failure seems to be the only condition present in both instances. Its connection with the vasomotor theory is discussed.

4. The time intervals between the operations and the occurrence we believe are the shortest ones yet reported postoperatively.

The operations were performed by Dr. Robert Sewell, Resident in Surgery, at the Strong Memorial and Rochester Municipal Hospitals. Bronchoscopies were carried out by Dr. Keith Tarrer, Resident in Otorhinolaryngology, at the Strong Memorial and Rochester Municipal Hospitals.

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THE TREATMENT OF ABSCESS OF THE THYROID GLAND CAUSING TRACHEAL OBSTRUCTION

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ABSCESS of the tyroid gland probably occurs more often than is indicated by the few cases reported in the literature. Tracheal obstruction is present in nearly all of the reported cases, an incidence higher than likely generally obtains. Abscess formation more commonly takes place in a diseased gland, particularly of the nodular type, the degenerated contents of a nodule being a favorable medium for bacterial growth. On the other hand, abscess may occur incident to an acute thyroiditis in a previously normal gland.[6] Infection commonly takes place by the blood stream, at times, but not necessarily as a result of a systemic infection. It may take place also by lymphatic channels in infections of the tonsils, larynx, or trachea.[4, 8] Except as just stated, the thyroid gland is seldom infected by lymphatics or by continuity from other cervical structures. The inflammatory process in the affected portion of the gland causes such rapid change in shape, increase in size, and tension as frequently to obstruct the trachea by pressure. A commonly associated inflammatory edema of the larynx and trachea may contribute to, or alone may cause obstruction to, respiration.[7] The systemic effect of the infection may be of any degree of severity depending upon the acuteness of the process, the type of the organism, and the physical characteristics of the abscess.

The course of events is generally rapid. The combination of respiratory obstruction and an acute infection makes a very ill patient. In the more fulminating cases a fatal outcome is prevented only by a timely diagnosis and proper treatment. The respiratory distress and the swelling in the neck are the commonly predominant findings. In anteriorly situated abscesses the overlying skin is warm and reddened. There is pain, induration, and fixation anteriorly and to one side of the trachea. In the more deeply situated abscesses there is little more than a sense of firmness on the affected side. Lehey calls attention to a limitation of the elevation of the chin, and a depression of the chin on swallowing.[4]

If the respiratory distress is not so great as to demand immediate operative relief, bed rest and sedation may result in such increase in breathing space as to make it possible to defer the operation for a few hours to a few days, thus leading to general improvement in the patient. During this period the infection tends to localize and to some ex-

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tent to subside, thus improving the operative risk. Proper sedation and supportive measures are used. Sulfonamide therapy would appear to be indicated but its use has not been reported. Morphia should be used sparingly and with care due to its depressant effect upon the respiratory center and its benumbing effect upon the consciousness resulting in a lessened respiratory effort. However much this waiting period may be desired, it is to be emphasized that a sustained respiratory effort of more than minimal degree is an absolute indication for a tracheotomy.[9] Failure to provide the patient with this means of relief will inevitably result in complete exhaustion, and only finally a rapidly developing cyanosis which is generally a sign of impending death.

Whether immediate or somewhat deferred, operation is indicated[1, 5, 6] for the relief of the respiratory obstruction, and drainage of the abscess to relieve the systemic infection and to prevent spread particularly into the mediastinum or perforation into the trachea.[2, 7]

The anesthesia of choice is the local infiltration of procaine. Inhalation anesthesia can not be administered safely or effectively through a narrowed and irritable air passage. Rectal or intravenous administration of the anesthetic agent is inadvisable because general anesthesia by any route deprives the patient of the conscious effort which is so important for obtaining adequate oxygenation in the presence of a narrowed airway. The use of an intratracheal catheter is to be avoided except with preliminary exposure of the trachea, since its introduction may be accompanied by such difficulty as to precipitate a complete obstruction to respiration. Also in such cases the trachea is particularly susceptible to damage as indicated by the report of cases in which it has been perforated by the abscess.[2, 3, 7] In these cases, cessation of respiration, whatever its cause, demands an immediate tracheotomy.[10] This must be performed under difficult conditions which add to the danger and decrease its effectiveness.

For operation the patient must be placed in a position which will afford him the greatest ease in breathing. This is generally an awkward position for the surgeon. The usual thyroid approach is made by a low collar incision with the formation of skin platysmal flaps. The prethyroid muscles, if not involved in the abscess wall, are divided in the midline and then transversely as indicated. Gentle manipulation and avoidance of pressure upon the trachea is of the utmost importance to avoid further obstruction to the respiration. The abscess is drained if it is readily accessible, otherwise the trachea is first exposed to permit a safe and quick tracheotomy, should it become necessary. Location and drainage of the abscess is then in order; excision of some of the infected glandular tissue is often advisable. This generally relieves the respiratory obstruction. However, as in one case reported here, tracheotomy may still be necessary on account of edema of the larynx. In all cases a portion of the trachea should be exposed in case a tracheotomy

should become necessary after operation. The wound is loosely closed with adequate provision made for drainage.

When abscess of the thyroid gland is treated in this manner, the result is generally a subsidence of the infection and a return to a normal thyroid balance.

CASE 1 (No. R 29563).—B. B., a single white woman, 73 years of age, was first seen, Nov. 8, 1938, at her residence where the rasping, stertorous breathing could be heard upon opening the front door. Her general health had been good until two weeks previously when she first noticed the sudden appearance of a swelling in her neck. Since then she had been conscious of pressure upon the trachea, and had had a coughing spell every morning. The coughing spells had increased in severity until on the morning of examination she was unable to breathe except with great difficulty. She was conscious and composed, but apprehensive. She was moderately exhausted but not cyanotic. The pulse rate was 120, its volume fair, and its rhythm somewhat irregular. There was a firm fixed swelling above the sternal notch and to the right. A diagnosis was made of nodular goiter which had undergone some internal change causing tracheal obstruction. The urgent need of a tracheotomy was recognized but rather than immediately attempt a difficult procedure under adverse conditions, she was given ¼ gr. of morphia and taken by ambulance directly to the operating room. Novocain was infiltrated locally. A low collar incision was made through the skin and platysma, and flaps were reflected. The prethyroid muscles were divided in the midline. An incision was then made through the overlying thyroid tissue to the trachea, which was displaced posteriorly and to the left, so as to be prepared for a hasty but safe tracheotomy. Mostly by digital manipulation, several large pieces of thyroid tissue were removed from the right side. The tissue was degenerated and suggested carcinoma. Thick pus exuded from several pockets. A limited examination of the partially exposed left lobe revealed some nodular enlargement. At this time breathing was much easier. Gauze was placed loosely in the cavity left by the removal of the thyroid tissue. The wound was partially closed, leaving adequate space for drainage. A culture of the pus was positive for a "pleomorphic gram-negative bacillus nonpathogenic." The pathologic examination showed a nodular goiter with follicles of both the distended and hyperplastic types. There were areas of cystic degeneration, necrosis, and scarring. One large area of necrosis showed suppuration at the periphery.

Soon after the patient returned to the ward the obstruction to breathing increased. The patient could not be aroused and a slight facial asymmetry suggested a cerebrovascular accident. Tracheotomy was decided upon and was performed with ease, through the exposed portion of the trachea, two hours after the original operation. Rapid improvement followed. Twenty-four hours later the larynx was seen to be clear and the vocal cords to move well, so the tracheotomy tube was removed and a gauze strip placed against the tracheal opening. Five days later the patient left the hospital with the tracheotomy opening closed and the neck wound discharging seropurulent material. The convalescence was uneventful and recovery was rapid.

On examination, Aug. 17, 1939, the wound was nicely healed. There was no palpable thyroid tissue. She had gained weight and her appearance was that of a normal thyroid balance; the only symptom was a slight unproductive cough. Three years after operation she has had no further trouble, except for an occasional irritative cough.

CASE 2 (No. R 115034).—R. D., a Negro woman, 80 years of age, was first examined Feb. 1, 1941. Two weeks previously she first became conscious of a swelling

in her neck. Since then she had experienced increasing difficulty in breathing, and later in swallowing. She was calm but having considerable difficulty in breathing. There was a firm, fixed tumor to the left of the trachea engaging the superior strait. Her temperature was 99.6° F., pulse 110, and blood pressure 160/96. The vocal cords could not be seen due to displacement and edema of the larynx. X-ray examination showed a dense irregular shadow behind the upper portion of the sternum displacing the trachea considerably to the right and also enlarged peribronchial lymph nodes. The white blood cell count was 9,100 with polymorphonuclears, 73 per cent. A diagnosis was made of nodular goiter undergoing some change with resultant pressure upon the trachea. Upon bed rest and mild sedation the breathing became much easier so operation was deferred to obtain improvement in the general condition of the patient.

Operation was performed Feb. 7, 1941. Under novocain infiltration a collar incision was made through the skin and platysma. Flaps were reflected. The prethyroid muscles were divided in the midline and then transversely on both sides. Dissection was next carried down to the trachea, which was exposed with difficulty due to its displacement and the overlying gland. The left lobe presented a firm mass which it was decided to remove. The superior attachments to the larynx were severed and while attempting to free it from the trachea, to which it was densely adherent, a quantity of pus escaped. The opening was enlarged and a thick walled cavity was encountered. This was emptied and was found to occupy the lower two-thirds of the left lobe which was resected almost completely. Limited exposure of the right lobe revealed only little enlargement. Hemostasis and closure were effected with cotton. A rubber tissue drain was placed to the left of the trachea. The airway was adequate throughout the operation. The convalescence was uneventful except for a purulent discharge from the wound. The patient was discharged from the hospital seventeen days after operation.

A culture of the pus from the abscess was positive for a nonhemolytic streptococcus. The pathologic report showed a cystic structure 7½ by 5 by 2 cm. The inner lining consisted of suppurative inflammatory tissue; the wall was thick and fibrous. An attached piece of thyroid gland was hyperplastic in places. In some areas there was cystic distention of the acini.

A few months after the operation and during the subsequent year there appeared suppurative tuberculous lymph nodes in the left posterolateral superior cervical region. Excision was performed on three occasions. Reexamination of the thyroid tissue removed at operation showed no evidence of tuberculosis. On April 17, 1942, fourteen months after operation, there was no palpable thyroid gland. She had gained weight and appeared to have a normal thyroid balance.

COMMENT

The two cases reported are both in elderly women with only two weeks of known duration of tumor in the neck. Respiratory obstruction in one necessitated immediate operation, in the other, operation could be deferred. In neither case was there but mild systemic infection. In both cases suppurative processes were found in glands previously diseased. In both cases the result of treatment has been satisfactory.

SUMMARY

1. Abscess of the thyroid gland is commonly productive of tracheal obstruction.

2. Early recognition with treatment by operative drainage is indicated and generally results in a cure.

3. Tracheotomy should be performed in case of sustained respiratory obstruction.

4. Two cases are reported.

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IMPRESSION TECHNIQUE FOR RECONSTRUCTION OF LARGE SKULL DEFECTS

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THE need occasionally arises for reconstructing defects of the skull which are unusually large and asymmetrical. When an inanimate transplant is used, it may be prepared to fit the defect accurately prior to operative repair. In the following few paragraphs we wish to describe a method for repair of large skull defects with plexiglass (methylmethacrylate).

TECHNIQUE

It is advantageous to secure a model of the patient's entire skull. This is particularly true if the defect extends into the temporofrontoorbital region. The model must include this area completely. The model of the entire skull may be obtained as follows. The patient's head is shaved and the scalp is lubricated with vaseline. A metal rim is applied to the base of the skull to which is attached a cardboard similar to a hat rim and about as wide. Indelible pencil marks are used to outline the defect by marking the scalp along the border of the defect. With a brush, a first layer of snow-white impression plaster No. 1 is applied to the head. When this is partially set, a well-dampened piece of gauze or cheesecloth is placed over the entire area to serve as a binder for the plaster. The purpose of the first application of a thin layer of plaster is to be assured that the unsupported tissue of the defect is not displaced by the second and heavier layer of plaster. A second heavy layer of plaster may then be applied, and when this is set, the impression is removed and a negative of the skull and its defect are thus obtained.

A positive may then be prepared by pouring artificial dental stone into the negative impression. Usually there is sufficient vaseline in the negative to permit the removal of the positive with ease. The positive should be placed on a suitable base in order to avoid injuries to its edges or to the defect border. The anatomic markings of the ear and ciliary arches should be present on the final mold. This master model is used instead of the patient for reconstructing the artificial graft with accuracy and convenience.

Particularly in large defects, templates may be used to obtain symmetrical building-up of the defect. A template in the horizontal and

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in the vertical position, cut out of cardboard and fitting the normal side, may then be placed on the side with the defect to note the extent of build-up necessary for bilateral symmetry.

The area of defect is then filled with artificial stone and the contour is corrected with the use of templates, adding plaster as needed to produce a symmetry corresponding to that of the normal side. The final build-up represents the contour which is desired when the skin overlies the graft.

The skull in the region of the build-up, in place, is lightly covered with vaseline. A negative impression of the area in defect with the build-up in place is then obtained with dental artificial stone or plaster. In order to compensate for the thickness of the skin, the inner surface of the negative may be reduced with Kerr's No. 28 gauge green soft wax in two thicknesses. In places where the skin is particularly thick, more thicknesses of wax may be used. From this corrected impression a positive model is prepared which represents the skull without overlying skin and which gives the desired contour for the graft. This positive may be made using dental stone. Plexiglass (methylmethacrylate) was used in this study. When plexiglass is used, an adequate amount is cut with a band saw. It is then gently heated with a dry flame from a Bunsen burner until it becomes soft and adaptable. The heated plexiglass is then adapted to the outer surface of the mold. In the process of the adaptation, the edges of the glass are beveled to produce an accurate fitting. Holes are drilled into the edges for the purpose of fixing the graft into position by means of appropriate suture material (steel wire). It is somewhat easier to make a negative of the mold and then adapt the warm plastic to its surface. In fact, the graft may be placed between the positive and the negative and be fixed into position.

CASE REPORT.—G. O., aged 21 years, was operated upon Aug. 3, 1939, at the Grace Hospital, for a large malignant meningioma growing in the left frontal lobe. The marked edema necessitated the sacrificing of the bone flap. Convalescence was satisfactory but the vision, which had been very poor before operation did not improve appreciably. The patient was given deep x-ray therapy in the left frontal lobe neighborhood. On Feb. 5, 1941, she was re-operated upon because of recurrent headaches and two generalized epileptic spells. At the second operation only a cherry-sized tumor was seen growing from the dura near the midline. The pathologic report was endotheliosarcoma of the dura. The brain in the frontal region appeared necrotic, pale white, and contained many small holes (cheeselike). Postoperatively, the patient had almost daily generalized and jacksonian spells, which were eventually controlled with phenobarbital and dilantin. Within a month the spells subsided and she had only one generalized attack until March 19, 1942, when the skull defect was repaired. Because of the disfiguring defect of the skull and dizziness on stooping, it was thought advisable to repair the skull defect with plexiglass. The proposed transplant was prepared prior to the operation in a manner described previously (Figs. 1 and 2). Figs. 3 to 7 show the patient before and after repair. The transplant was sterilized by immersion in 95 per cent alcohol for twenty-four hours. It was washed in distilled water before use. The transplant fitted

the defect perfectly and no correction was necessary at the time of the operation. It was held in place by wire sutures. Small holes were made with the hand drill in the skull and in the transplant for suture. The subcutaneous tissue and the skin were sutured over the transplant with interrupted silk with no drainage. Within twenty-four hours there was a collection of serum under the skin. This was thin, brownish in color, and drained easily with a No. 18 needle inserted subcutaneously. A smaller

Fig. 1.—To the left is shown a model of the skull with its defect to be repaired. To the right is shown a positive and negative of the area of defect after build-up. The plexiglass graft is held in the right hand.

Fig. 2.—To the left is shown the piaster model of the skull with the defect eliminated by the use of the plexiglass graft. To the right is shown the positive and negative of the area of defect after build-up.

Fig. 3.—Appearance of patient prior to repair of postoperative skull defect after removal of a large frontal meningioma.

Figs. 4 and 5.—The appearance of patient following repair of the skull defect with plexiglass graft. Figs. 1 and 2 illustrate the same case.

collection was drained the following day. Thereafter there was no collection of fluid and the wound healed by primary intention. During the ensuing ten days, the patient had many minor generalized convulsions in much the same manner as after the second operation. These were controlled with sedatives. In the following thirteen months there was no recurrence of these attacks and during the following fifteen months there were no reactive changes due to the transplant. Further dizziness from bending down ceased to be a complaint.

Figs. 6 and 7.—Anteroposterior and lateral view of patient one year after repair.

DISCUSSION

The subject of repair of skull defects has been studied and the literature reviewed with great care by Grant and Norcross.[1] Several articles have appeared in the literature, since 1938, on the use of inanimate transplants for large defects of the skull. The contributions of Geib,[2] Lipscomb and Grover,[3] Beck,[4] Venable and Stuck,[5] and Pudenz[6] discuss the problem from the standpoint of the use of vitallium and tantalum. It is suggested that the fitting of the transplant to the patient's defect be done at the time of the operation, which we consider to be a disadvantage, particularly if the defect is asymmetrical and possesses many and varied changes in symmetry. In such instances, the preoperative preparation of the transplant, be it tantalum, vitallium, or plastic, is preferable. Only a very small amount of readjusting should be necessary at the time of the operative repair of the defect. In the case of the plastic that has been used in this study, such fitting can be done easily by exposing the transplant to dry heat on the Bunsen burner immediately next door to the operating room or in the operating room, if local anesthesia is used.

Plexiglass (methylmethacrylate) has been used for the construction of femoral head[7] with apparently good results. Cameron[8] also has used the material for skull defects and considers it superior to metallic transplants because the plastic transplant is transparent to x-ray and also because it is sturdy and retains its shape.

The purpose of the present communication is not so much to discuss the merits or the disadvantages of plexiglass as a transplant material but more to bring out the described impression technique for the preoperative preparation of the transplant. It seems to us that this is a great advantage in extensive defects in the skull in the frontotemporoorbital region.

The management of smaller defects of the skull by osteoperiosteal transplant from the patient's skull or with rib transplant is generally accepted of proved value. This subject was discussed in a previous article in 1935.[9] We have had the opportunity to use osteoperiosteal transplant from the outer layer of the skull on many subsequent instances with excellent results.

CONCLUSIONS

An impression technique for the building of inanimate transplant for large skull defects is described. In this case methylmethacrylate (plexiglass) was used and at the end of fifteen months was still in excellent repair with no evidence of deleterious reactions to the patient.

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CONGENITAL ATRESIA OF THE ESOPHAGUS

The Description of an Operative Procedure

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CONGENITAL atresia of the esophagus occurs sufficiently infrequently that few physicians see many of these anomalies. The surgical treatment of this condition has been most unsatisfactory, but it appears now that the solution of this problem is not far distant. It seems desirable, therefore, that any possible attack on this problem be reported so that the technique may be incorporated into whatever procedure may soon prove itself.

Some 330 cases have been reported and are included in recent reviews of this subject.[1-4] A simple, practical, clinical classification of these anomalies was published in 1929 by Vogt.[5] His classification is presented schematically in Fig. 1. Because of its more frequent occurrence, Type III*B* is of greatest surgical importance.

DIAGNOSIS

The diagnosis of esophageal atresia can be made during the first few hours of life by the recurring attacks of coughing, choking, and cyanosis which are aggravated when fluid is given by mouth. Also, there will be an excessive amount of frothy spittle coming from the infant's mouth. The suspicion of the presence of an esophageal anomaly is confirmed by x-ray study. In all types of esophageal atresia, except Type I, a catheter can be introduced into the proximal segment, and the length of the segment demonstrated by x-ray by the distance to which the catheter can be inserted. Radiographically opaque fluid media should not be used. They contribute nothing to the diagnosis with the possible exception of instances of Type III*A*, and may cause damage by their aspiration into the bronchioles and periphery of a lung already involved by a varying degree of inflammation. The absence of gas in the gastrointestinal tract will eliminate the presence of Type III*B* or III*C*. The extent of pneumonitis and pneumonia preoperatively should be evaluated as a guide to prognosis. Satisfactory treatment is largely dependent upon early diagnosis before an aspiration pneumonia has occurred, but sufficient time can be taken for the proper hydration of the patient. Both whole blood and plasma may be given by intramedullary transfusion.

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TREATMENT

Various workers have attacked the important problem of eliminating regurgitation from the stomach with its consequent flooding of the pulmonary tree. The procedures to accomplish this result were reviewed by Carter,[6] in 1941.

In 1936, Leven,[7] exteriorized the cardiac ends of the esophagus and stomach, intending that the resulting angulation would prevent regurgitation. In the same year, Gage and Ochsner[3] proposed the ligation of the cardiac end of the esophagus. In the discussion of this report, Mixter reported having ligated and divided the fistulous communication through a right-sided extrapleural approach, the distal esophagus being brought out dorsally and a tube introduced for the purpose of feeding. Likewise, in 1936, Heatly[8] attempted to eliminate regurgitation by closing the cardiac end of the stomach and performing an abdominal esophagostomy to drain the distal segment of the esophagus of two patients. One of the patients lived for 145 days.

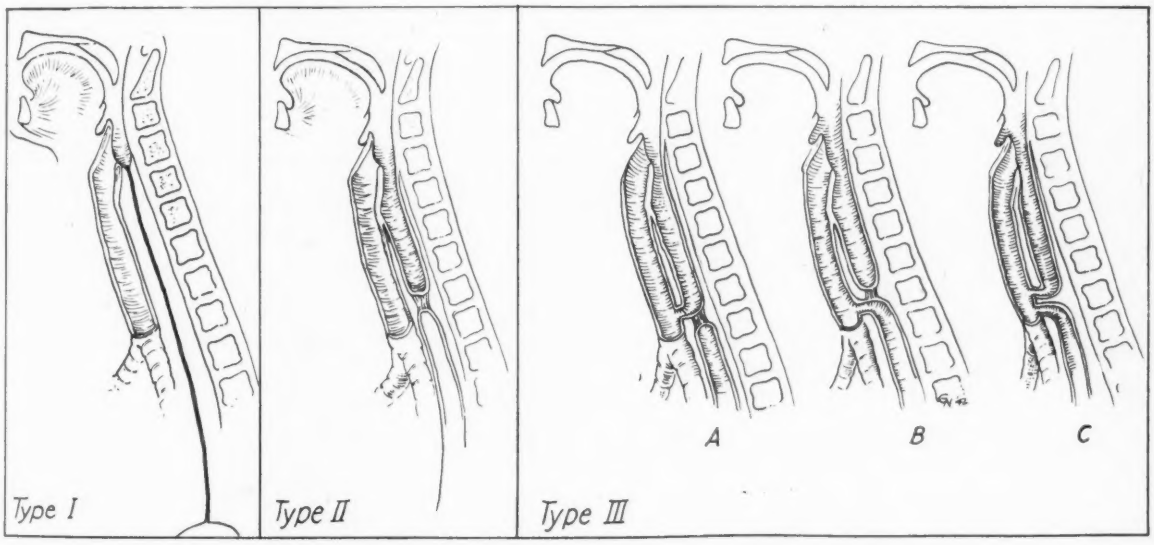

Fig. 1.—A schematic representation of the usual clinically significant types of esophageal anomalies. *Type I,* Congenital absence of esophagus (rare). *Type II,* Blind upper and lower segments of esophagus (rare). *Type III,* Tracheo-esophageal fistulas: *A,* Upper segment of esophagus communicating with the trachea; lower segment blind (rare). *B,* Upper segment of esophagus blind; lower segment communicating with the trachea (occurring most frequently). *C,* Both upper and lower segments of the esophagus communicating with trachea (rare). (Modified from Cole, W. H.: Arch. Surg. 23: 820, 1931.)

I agree with Lanman,[4] Leven,[9] and many others interested in this problem, that the first step of the operation on tracheo-esophageal fistulas of Type III*B* and III*C* is a direct attack on the fistula, and if an immediate anastomosis cannot be effected between the upper and lower segments of the esophagus, the Types III*B* and III*C* are converted into Types II or III*A*. The all-important consideration is that the esophagus be disconnected from the trachea to prevent regurgitation of stomach

contents into the trachea. Within the next three days a Witzel gastrostomy should be performed in order that the infant can be fed. After these manipulations the proximal esophageal segment must be brought out to form a cervical fistula. Should the patient be free of other congenital anomalies and survive the three preceding operations, one is faced with extensive plastic operations to construct an extrathoracic tube connecting the upper esophageal segment with the stomach.[6, 9, 10]

Because of the relative frequency of Type III*B*, its treatment is more important than all of the other forms combined. Obviously, a direct attack on the fistula with an immediate anastomosis of the upper and lower segments of the esophagus is desirable and should give the best results once a technique will ensure success.* Ordinarily, an anastomosis can be done without extensive freeing of either the proximal or distal segments of the esophagus if the segments are not separated by more than 2 cm. It should be noted, however, that the distal segment of the esophagus together with surrounding connective tissue can be liberated even to the freeing of the cardiac portion of stomach and esophagus at the diaphragm. Such a procedure would permit the cardia to be brought up above the diaphragm with a resulting relaxation which would permit a direct end-to-end esophageal anastomosis where the gap between the upper and lower segments exceeds 2 cm. In this instance a transpleural approach is required for sufficient exposure.

The following procedure is outlined because it gives promise of eventual success. After the insertion of a No. 14 French soft rubber catheter into the upper segment of the esophagus, the patient is placed in the prone position with the right arm extended over the head. Because of the danger of inadvertently opening the pleura with collapse of the lung, provision must be made to administer the anesthetic under pressure. During prevoius fluoroscopic examination a paper clip is fixed over the right fifth rib posteriorly under a strip of adhesive. When the skin is prepared, the metal clip is removed, and its impression on the skin marks the level of the fifth rib accurately. The incision begins at the level of the second rib, extends downward just to the right of the midline to the level of the fifth rib to turn laterally along the lower border of the scapula, and is carried outward to the posterior axillary line. Two inches of the fourth rib are excised subperiosteally extending outward from the transverse process. The third and fifth, and occasionally the second and sixth, ribs are transected

*Since the preparation of this manuscript, an excellent article by Haight and Towsley[13] announced the first successful cure of tracheo-esophageal fistula by immediate anastomosis of the esophagus. In this instance, true primary healing did not occur. An esophageal fistula developed to persist for a short period. More recently, A. O. Singleton has successfully performed an immediate anastomosis over a catheter with primary healing. I am advised by Owen H. Wangensteen (June 8, 1943) that N. Logan Leven has successfully treated four cases of congenital tracheo-esophageal fistula.

close to the transverse processes. The pleura is exposed by a T-shaped incision extending outward just superior to the fourth rib and including the section of the third, fourth, and fifth intercostal muscle bundles, nerves, and blood vessels as near the transverse processes as possible.

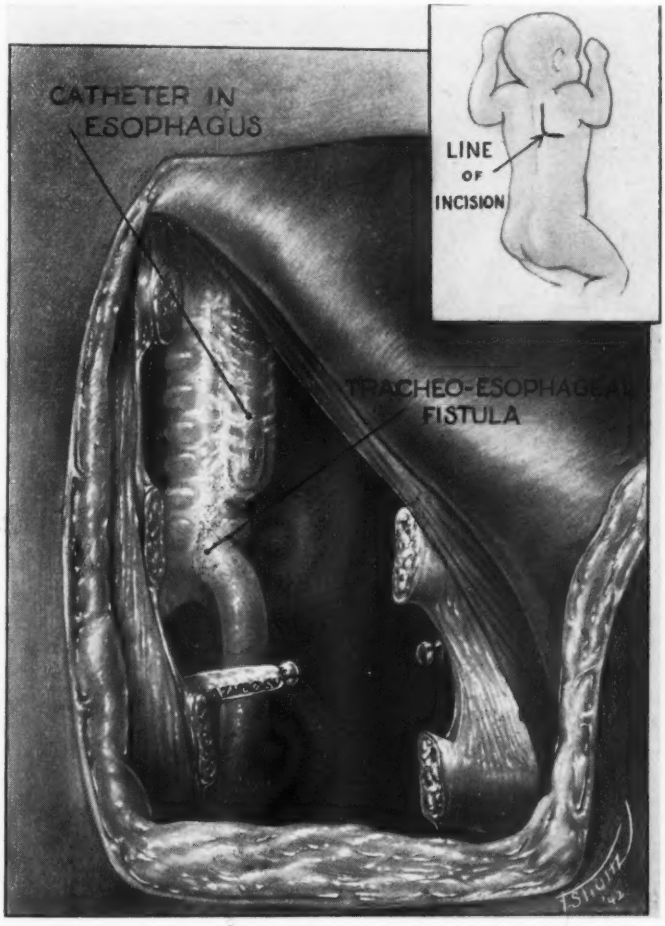

Fig. 2.—Illustrating the catheter showing through the wall of the upper segment of esophagus and the lower segment of the esophagus in a case suitable for immediate anastomosis of the two segments over a catheter. The presence of the catheter aids in the identification of the upper segment. The azygos vein has been divided.

The operator enters the mediastinum by staying close to the vertebral column and carefully pushing aside the pleura. The horizontal portion of the azygos vein, where it crosses above the bifurcation of the trachea to join the superior vena cava, is the first prominent structure encountered. This vessel should be divided to give a direct approach to the esophagus at a level just superior to the carina. Careful dissection of the immediate areolar tissue will uncover the esophagus. If at this point the anesthetist will push on the catheter, its tip is readily identified, provided the upper segment is sufficiently long to

allow anastomosis between the two segments of esophagus. The presence of the catheter likewise shows the anteroposterior level of the esophagus and gives an excellent guide to its lower segment. A small electric bulb on a flexible carrier, passed into the catheter, is an additional aid in locating the tip of the catheter even though the upper

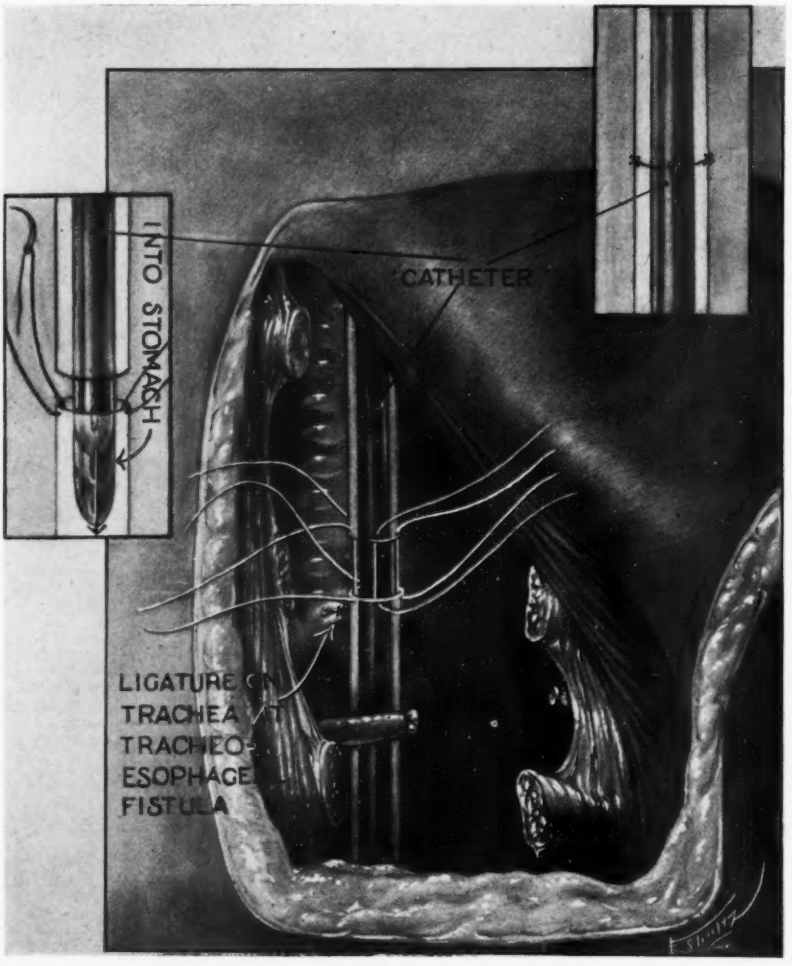

Fig. 3.—A demonstration of the immediate anastomosis of the esophageal segments over an indwelling catheter. The catheter has been introduced into the stomach. The diameter of the catheter should be considerably smaller than that of the esophagus to permit drainage of secretions.

segment is too high to permit direct anastomosis of the segment. The upper and lower segments of the esophagus cannot be anastomosed if the ends are separated by more than 2 cm. without extensive freeing of the distal segment. The tracheo-esophageal fistula is identified, isolated, and ligated adjacent to the trachea. If an immediate anastomosis is possible, the distal segment of the esophagus is divided, as near the tracheo-esophageal fistula as possible. If, however, an anas-

tomosis is impossible, the esophagus is doubly ligated and divided between the ligatures, and the first stage operation is complete.

For immediate anastomosis, minimum lengths of the upper and lower segments of the esophagus are freed. The end of the upper segment is fixed with a traction suture and opened, the catheter is directed into the lower segment and pushed down to enter the stomach, and the esophagus is anastomosed over the catheter, using four simple interrupted sutures.

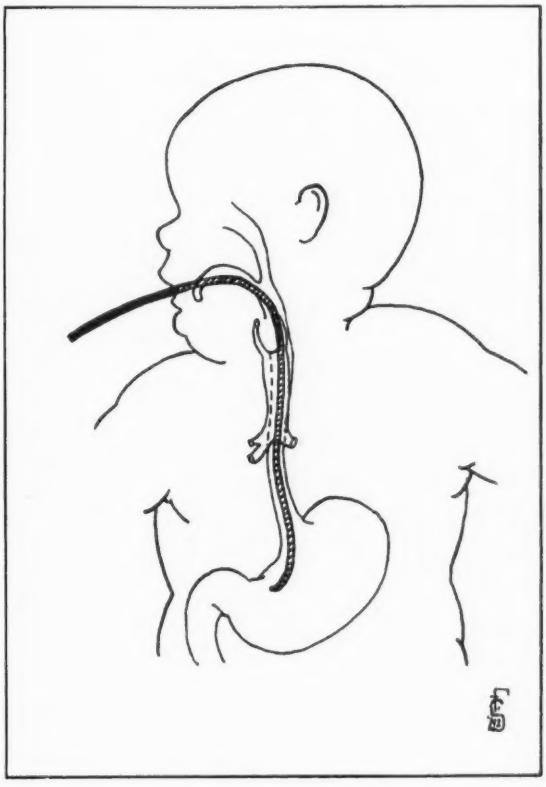

Fig. 4.—A schematic demonstration of the catheter in place permitting feeding during the immediate postoperative period.

After it has been determined that the pleura has not been accidentally damaged and that air has not entered the pleural space, the wound is lightly powdered with sterile sulfanilamide and closed. A simple rubber tissue drain extends into the depths of the wound.

With a tube in the stomach, the infant can be fed immediately and should be given its formula in small amounts each hour. The tube is left open between feedings. The patient is turned frequently and the head is kept lowered and turned to one side. Sulfadiazine should be given before operation and this therapy should be continued postoperatively as a safeguard against pneumonia.

CASE REPORT

M. J., an 11-day-old female infant, was admitted to the Johns Hopkins Hospital on Feb. 26, 1942, with a typical story of esophageal atresia. For eleven days the infant had been fed at regular intervals with disregard of the attacks of coughing and cyanosis with regurgitation of fluids taken by mouth. An x-ray examination with a catheter in the esophagus showed an obstruction opposite the level of the fourth rib and gas in the gastrointestinal tract. The lung fields showed x-ray evidence of extensive pneumonic consolidation. The patient was extremely dehydrated and cyanotic. Because of her poor condition she was given intravenous and subcutaneous fluids and sulfadiazine for 36 hours before operation was undertaken.

Operation was performed through a posterior, extrapleural approach; about two inches of the fourth and fifth ribs were resected, and the third and sixth ribs were cut near the transverse processes. The exposure was adequate. The catheter in the upper segment served as an excellent guide to both upper and lower segments of the esophagus. The tracheo-esophageal fistula, located just above the bifurcation of the trachea, was isolated, ligated, and divided. About 1 cm. of each esophageal segment was freed, the upper segment transfixed with a traction suture and opened, the indwelling catheter passed down the lower esophageal segment into the stomach, and the esophagus anastomosed over the catheter, four simple interrupted silk sutures being used. About ½ Gm. of sterile sulfanilamide powder was sprinkled into the depths of the wound, the mediastinum was drained with a small piece of rubber tissue, and the wound closed with fine silk. The position of the catheter in the stomach was checked by fluoroscopy.

Twelve hours after operation the feeding formula was started by means of the indwelling tube in small amounts each hour. All fluids and medications were administered through the catheter and were well tolerated.

The infant, although kept in an oxygen tent, continued to be cyanotic and died on the fifth post-operative day. The heart continued to beat for some time after respiration ceased. At autopsy it was found that a pleural effusion had partially collapsed the right lung. The left lower lung was involved in a grayish consolidation. The operative field was clean and dry. The esophageal anastomosis was intact, the esophagus appeared normal with a good blood supply, and the anastomosing sutures showed no evidence of tension. The ductus arteriosus was open and about 2 mm. across, and the pericardial cavity contained about 50 c.c. of straw colored fluid.

DISCUSSION

During the past year I have treated four patients with congenital atresia of the esophagus with tracheo-esophageal fistula, all of Type III*B*, Fig. 1. One of these patients had, in addition, an atresia of the rectum. One instance was the case herein reported, in which it was possible to perform a primary anastomosis over a tube.

In this operative procedure a successful anastomosis over a catheter would restore the patient to an essentially normal condition by a single operation. The catheter extending into the stomach would permit immediate feeding, which should contribute much to a successful outcome.

It must be recognized that a tube in the stomach of an infant induces a pylorospasm and tends to induce regurgitation. It is, therefore, best not to perform a Witzel gastrostomy in any case before the tracheo-

esophageal fistula has been closed. In the event a gastrostomy is subsequently necessary, the tube should extend beyond the pylorus. A few days after the closure of the fistula and establishment of continuity of the esophagus, a gastrostomy may be indicated because it will permit the distal end of the indwelling catheter in the esophagus to be brought to the outside. A braided silk thread can be tied into the proximal end of the catheter, the catheter drawn distally so that its proximal opening lies in the esophagus superior to the anastomosis to drain saliva and mucus, and the catheter eventually withdrawn distally to leave a silk thread in the esophagus to facilitate subsequent dilatation of the stricture which will probably occur at the site of the anastomosis.

Leven,[7] Peyton,[11] and Wangensteen[12] found that infants do not tolerate well an indwelling catheter whether it be brought out of the mouth or introduced as a nasal tube. The presence of the tube predisposes to otitis media. Sulfonamide therapy during this period might well prevent the development of an otitis media, and the combined use of an indwelling catheter and sulfonamide therapy is worthy of a trial in a condition demanding heroic procedure.

A review of past attempts to correct esophageal atresia indicates that if the upper and lower segments of the esophagus cannot be joined by direct anastomosis, the first procedure on a patient with a tracheo-esophageal fistula of Types III-*B* and III*C* should be a direct attack to sever the connection between the distal esophagus and the trachea and thereby prevent regurgitation and flooding of the lungs with secretions from the stomach. In the presence of esophageal atresia with a tracheo-esophageal fistula, aspiration may occur from the accumulation of saliva and fluids given by mouth or from the regurgitation of stomach contents. Of these possibilities, that of regurgitation seems the most serious and consequently the patient's head should not be placed dependent before the fistulous opening is closed. After the abnormal communication has been closed, then the head can and should be dependent to permit better drainage of saliva and mucus. The accumulated mucus should be aspirated frequently. Congenital esophageal atresia should be considered a condition demanding immediate surgical treatment.

Final success in the correction of this anomaly will largely depend upon early diagnosis and operation before pneumonic aspiration and infection have occurred. The obstetrician and pediatrician can do much in this solution by early definitive diagnosis without introducing fluid radiopaque media into the upper esophageal segment to be possibly aspirated subsequently.

SUMMARY

A possible operative attack on congenital tracheoesophageal fistula is outlined.

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EXPERIMENTAL STUDIES ON ALIMENTARY AZOTEMIA

IV. Role of the Liver and Kidneys

Henry N. Harkins, M.D., Ph.D., Donald H. Hooker,* M.D., Robert T. Boals,* M.S., M.D., Brock E. Brush, M.S., M.D., and C. Frank Chunn,* M.S., M.D., Detroit, Mich.

(From the Division of General Surgery, Henry Ford Hospital, Detroit)

IN THE three previous papers[1, 2 and 3] of this series, the following facts were demonstrated: (1) The increase in blood urea nitrogen associated with the presence of blood in the intestinal tract is in large part due to the absorption of the blood. (2) The protein in the blood, and especially that in the red cell fraction, more or less quantitatively accounts for the degree of the azotemia. (3) Azotemia results to a much greater degree when the blood is in the upper than in the lower intestinal tract.

The present study of this syndrome considers the amount of azotemia which occurs in experimental animals with impaired hepatic circulation following the ingestion of blood. For this purpose four sets of experimental preparations were used. In all instances, dogs were utilized. The four preparations included: (1) animals with an Eck fistula (portal vein ligated and the portal circulation shunted into the inferior vena cava), (2) animals with a reverse Eck fistula (inferior vena cava ligated and its blood shunted into the portal vein so that all blood from the lower half of the body goes through the liver), (3) animals with both the portal vein and inferior vena cava ligated (thus representing the condition after the second stage of a three-stage hepatectomy, a reverse Eck fistula being made at the first stage and several weeks later the portal vein being ligated), and (4) animals after total hepatectomy.

ANIMALS WITH ECK FISTULA

The blood urea nitrogen levels were observed following the administration of whole blood or red blood cells by stomach tube in standard doses as described in the previous articles in this series. In five such experiments, there was practically no elevation in blood urea nitrogen, typical results being shown in Figs. 1, 2, and 3.

*Now on active duty with the Armed Forces of the United States.

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ANIMALS WITH REVERSE ECK FISTULA

Similar doses of whole blood or of red blood cells were given to eight dogs with reverse Eck fistulas. In all instances a definite rise in blood

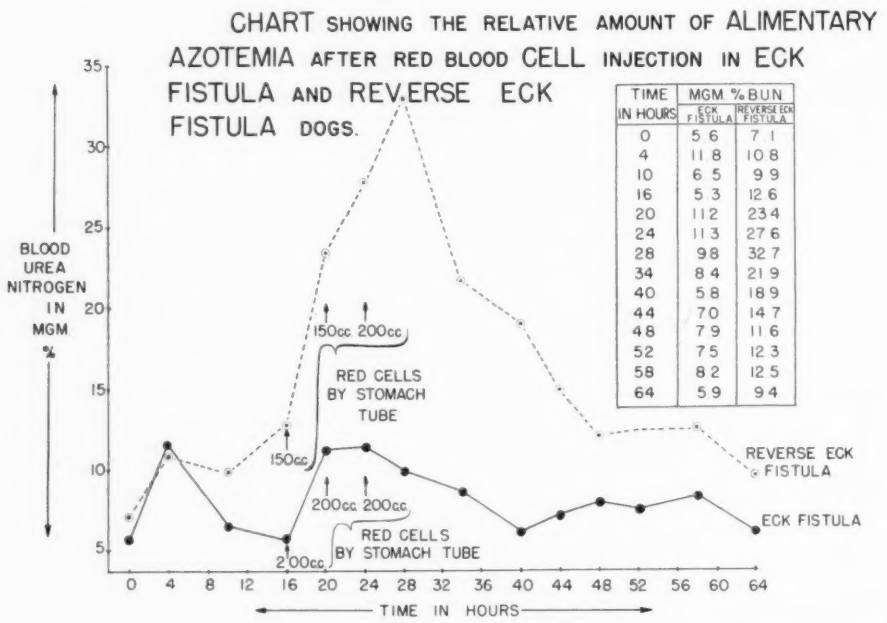
CHART SHOWING THE RELATIVE AMOUNT OF ALIMENTARY AZOTEMIA AFTER RED BLOOD CELL INJECTION IN ECK FISTULA AND REVERSE ECK FISTULA DOGS.
BLOOD UREA NITROGEN IN MGM %
150cc 200cc
RED CELLS BY STOMACH TUBE
150cc
200cc 200cc
RED CELLS BY STOMACH TUBE
200cc
REVERSE ECK FISTULA
ECK FISTULA
TIME IN HOURS
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64
5 10 15 20 25 30 35

TIME IN HOURS	MGM % BUN	
	ECK FISTULA	REVERSE ECK FISTULA
0	5 6	7 1
4	11 8	10 8
10	6 5	9 9
16	5 3	12 6
20	11 2	23 4
24	11 3	27 6
28	9 8	32 7
34	8 4	21 9
40	5 8	18 9
44	7 0	14 7
48	7 9	11 6
52	7 5	12 3
58	8 2	12 5
64	5 9	9 4

Fig. 1.—Alimentary azotemia in a dog with Eck fistula (below) and with reverse Eck fistula (above).

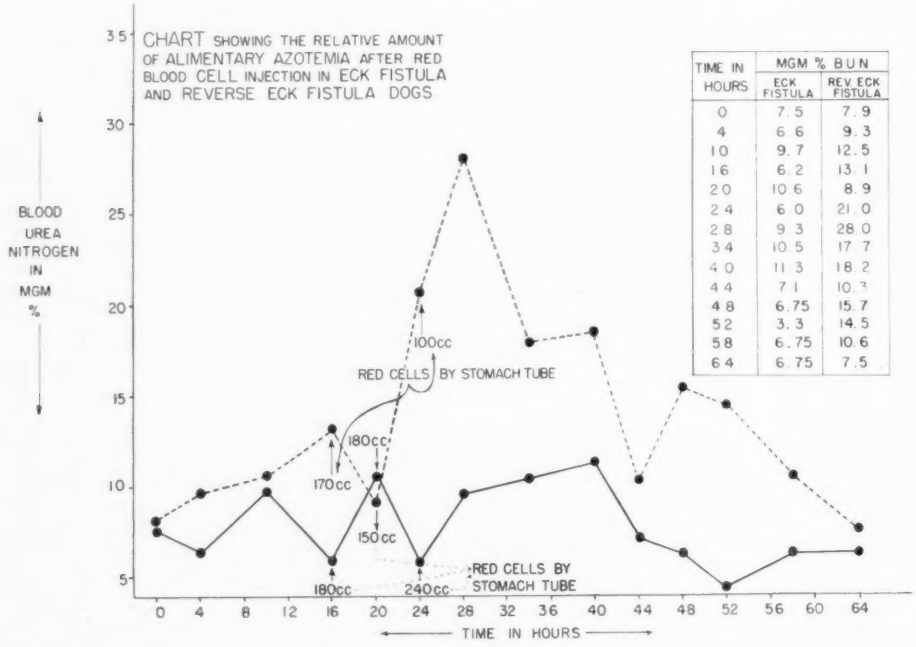
CHART SHOWING THE RELATIVE AMOUNT OF ALIMENTARY AZOTEMIA AFTER RED BLOOD CELL INJECTION IN ECK FISTULA AND REVERSE ECK FISTULA DOGS
BLOOD UREA NITROGEN IN MGM %
100cc
RED CELLS BY STOMACH TUBE
180cc
170cc
150cc
180cc
240cc
RED CELLS BY STOMACH TUBE
TIME IN HOURS
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64
5 10 15 20 25 30 35

TIME IN HOURS	MGM % BUN	
	ECK FISTULA	REV. ECK FISTULA
0	7.5	7.9
4	6.6	9.3
10	9.7	12.5
16	6.2	13.1
20	10.6	8.9
24	6.0	21.0
28	9.3	28.0
34	10.5	17.7
40	11.3	18.2
44	7.1	10.3
48	6.75	15.7
52	3.3	14.5
58	6.75	10.6
64	6.75	7.5

Fig. 2.—Same as Fig. 1. The solid line below represents the dog with the Eck fistula and the broken line above represents the dog with the reverse Eck fistula.

urea nitrogen resulted as shown in three typical experiments in Figs. 1, 2, and 3. In one other experiment not shown in the figures, the blood urea nitrogen rose from 11 to 46 mg. per cent. In four of the dogs with reverse Eck fistulas, the rise was classified as moderate (see Figs. 2 and 3), and in the four others it was classified as marked (see Fig. 1). In all cases the increase was much greater than that occurring in the animals with Eck fistulas. Also, in every instance it was as marked as that occurring in normal dogs and, in several cases, was definitely more than would be expected in normal dogs.

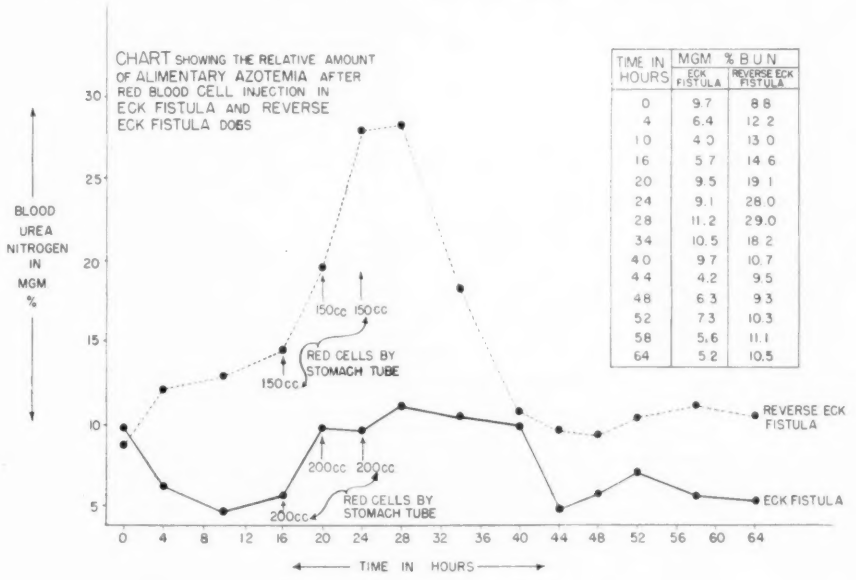
CHART SHOWING THE RELATIVE AMOUNT OF ALIMENTARY AZOTEMIA AFTER RED BLOOD CELL INJECTION IN ECK FISTULA AND REVERSE ECK FISTULA DOGS
BLOOD UREA NITROGEN IN MGM %
150cc
150cc
150cc
RED CELLS BY STOMACH TUBE
200cc
200cc
200cc
RED CELLS BY STOMACH TUBE
REVERSE ECK FISTULA
ECK FISTULA
TIME IN HOURS
TIME IN HOURS | MGM % B.U.N. | ECK FISTULA | REVERSE ECK FISTULA
0 | 9.7 | 8.8
4 | 6.4 | 12.2
10 | 4.0 | 13.0
16 | 5.7 | 14.6
20 | 9.5 | 19.1
24 | 9.1 | 28.0
28 | 11.2 | 29.0
34 | 10.5 | 18.2
40 | 9.7 | 10.7
44 | 4.2 | 9.5
48 | 6.3 | 9.3
52 | 7.3 | 10.3
58 | 5.6 | 11.1
64 | 5.2 | 10.5

Fig. 3.—The same as Fig. 2.

ANIMALS WITH BOTH PORTAL VEIN AND VENA CAVA LIGATED

In two such animals, after the administration of red blood cells by stomach tube, a moderate rise in blood urea nitrogen occurred as shown in Fig. 4. This rise was roughly proportionate to that occurring in normal animals, and while less than that resulting in most of the dogs with reverse Eck fistulas, it was far more than that noted in any of the dogs with Eck fistulas.

HEPATECTOMIZED ANIMALS

Red blood cells were given by duodenostomy tube to five dogs following total hepatectomy. In no instance was there a marked rise in the blood urea nitrogen. In one experiment shown in Fig. 5, the level fell slightly at first and rose terminally. In another experiment not illustrated, the level fell slightly until just before death and then dropped to 2 mg. per cent just at the time of death. The results in the other three experiments are demonstrated in Fig. 6: in one no change; in two a definite decrease.

The method of performing the urea analyses was described in the first article of this series.[1] It is essentially that of Van Slyke and Cullen. While check readings on the same sample of blood were usually accurate

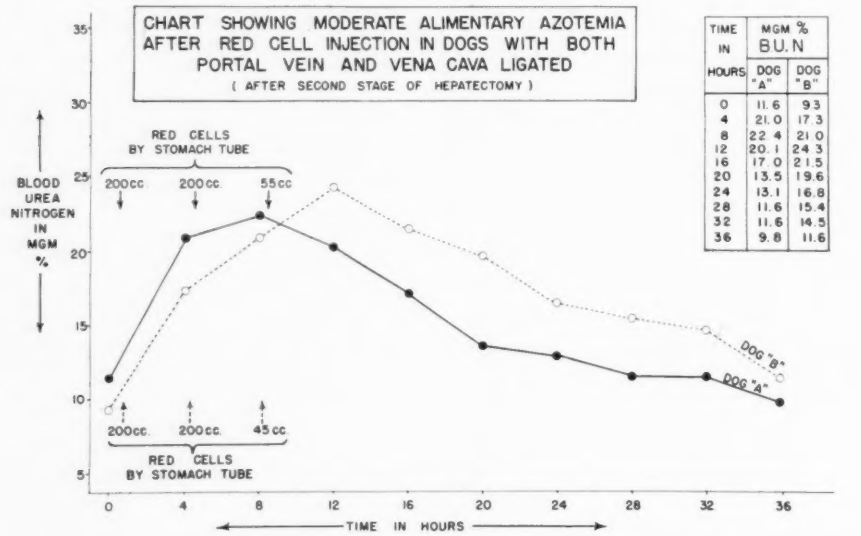
CHART SHOWING MODERATE ALIMENTARY AZOTEMIA AFTER RED CELL INJECTION IN DOGS WITH BOTH PORTAL VEIN AND VENA CAVA LIGATED
(AFTER SECOND STAGE OF HEPATECTOMY)
BLOOD UREA NITROGEN IN MGM %
RED CELLS BY STOMACH TUBE
200cc. 200cc. 55cc
200cc. 200cc. 45cc.
RED CELLS BY STOMACH TUBE
DOG "B"
DOG "A"
TIME IN HOURS
0 4 8 12 16 20 24 28 32 36
5 10 15 20 25 30 35

TIME IN HOURS	MGM % B.U.N DOG "A"	DOG "B"
0	11.6	9.3
4	21.0	17.3
8	22.4	21.0
12	20.1	24.3
16	17.0	21.5
20	13.5	19.6
24	13.1	16.8
28	11.6	15.4
32	11.6	14.5
36	9.8	11.6

Fig. 4.—Alimentary azotemia in two dogs with both portal vein and vena cava ligated.

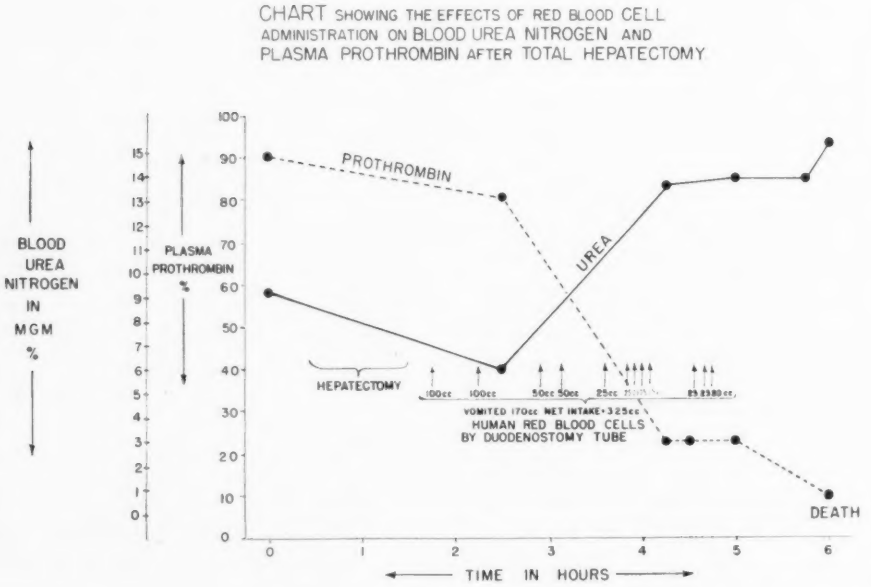
CHART SHOWING THE EFFECTS OF RED BLOOD CELL ADMINISTRATION ON BLOOD UREA NITROGEN AND PLASMA PROTHROMBIN AFTER TOTAL HEPATECTOMY
BLOOD UREA NITROGEN IN MGM %
PLASMA PROTHROMBIN %
PROTHROMBIN
UREA
HEPATECTOMY
100cc 100cc 50cc 50cc 25cc
VOMITED 170cc NET INTAKE +325cc
HUMAN RED BLOOD CELLS BY DUODENOSTOMY TUBE
DEATH
TIME IN HOURS
0 1 2 3 4 5 6

Fig. 5.—Changes in blood urea nitrogen and plasma prothrombin after total hepatectomy.

to within 2 to 3 mg. per cent, we believe the rise in blood urea nitrogen in the single experiment shown in Fig. 5 must in some way represent

an experimental error rather than evidence of blood urea formation in the absence of the liver.

Associated Prothrombin Levels.—While the decrease in plasma prothrombin following hepatectomy has been observed before, this observa-

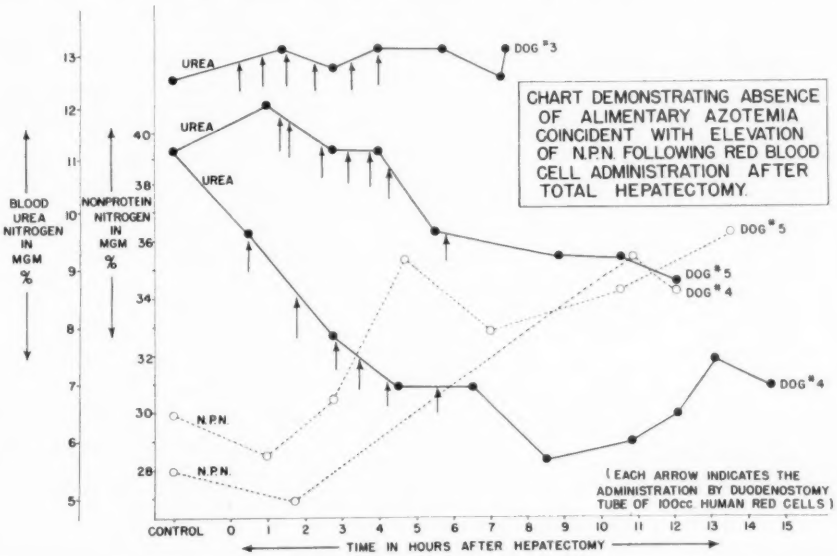
CHART DEMONSTRATING ABSENCE OF ALIMENTARY AZOTEMIA COINCIDENT WITH ELEVATION OF N.P.N. FOLLOWING RED BLOOD CELL ADMINISTRATION AFTER TOTAL HEPATECTOMY.
BLOOD UREA NITROGEN IN MGM %
NONPROTEIN NITROGEN IN MGM %
UREA
UREA
UREA
N.P.N.
N.P.N.
DOG #3
DOG #5
DOG #5
DOG #4
DOG #4
(EACH ARROW INDICATES THE ADMINISTRATION BY DUODENOSTOMY TUBE OF 100cc HUMAN RED CELLS)
CONTROL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
TIME IN HOURS AFTER HEPATECTOMY

Fig. 6.—Contrasting changes in blood urea nitrogen and nonprotein nitrogen following hepatectomy.

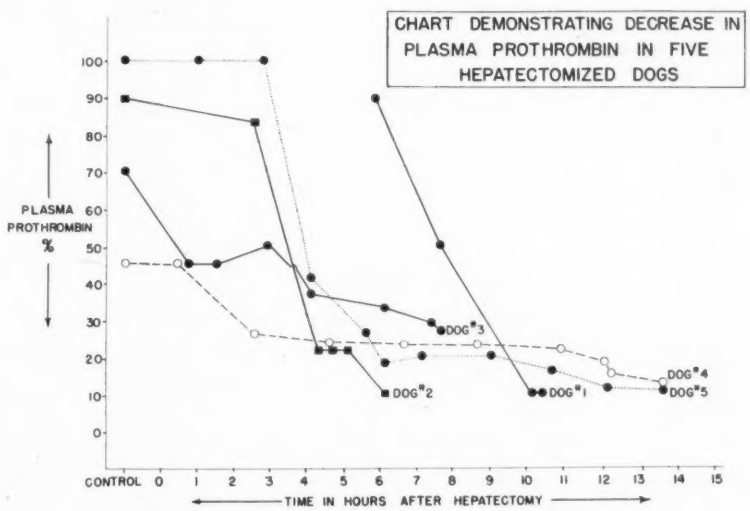
CHART DEMONSTRATING DECREASE IN PLASMA PROTHROMBIN IN FIVE HEPATECTOMIZED DOGS
PLASMA PROTHROMBIN %
DOG #3
DOG #2
DOG #1
DOG #4
DOG #5
CONTROL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
TIME IN HOURS AFTER HEPATECTOMY

Fig. 7.—Decrease in prothrombin in five hepatectomized dogs.

tion has been reported in the literature so little as to deserve re-emphasis here. In Fig. 7, a fall in prothrombin level in all five dogs is demonstrated.

Associated Rise in Blood Nonprotein Nitrogen Levels.—In two animals, blood nonprotein nitrogen levels exhibited a definite rise as shown

in Fig. 6. It is of especial interest that these two dogs showed the most steady decrease in blood urea nitrogen, demonstrating the lack of parallelism between the changes in these two nitrogenous compounds in these experiments.

BRIEF NOTE ON ROLE OF KIDNEYS IN ALIMENTARY AZOTEMIA

Our observations in this regard are too scant to warrant other than a brief note at this time, especially since only one aspect of the subject is touched upon. Two dogs with kidney damage produced from roentgen rays by the method of Hartman were used.* Red blood cells were administered by stomach tube, and in both animals a rise in blood urea nitrogen occurred. This rise was relatively of about the same extent as that occurring in normal dogs, but was characterized by two differences: (1) It tended to be more prolonged, and (2) it started from a higher base line (about 40 to 50 mg. per cent).

COMMENT

The study of increased blood urea nitrogen following the introduction of blood into the intestinal tract is not only of academic but of practical interest. In the treatment of bleeding peptic ulcer the condition is also of importance. In a case where one is in doubt as to whether or not to operate, an increased blood urea due to renal or hepatic involvement might influence the decision far more than an elevation due to absorption of digested blood. It was because of this manifest difference in the importance of the syndrome depending on its cause that we started the present studies.

The name azotemia has been applied to this syndrome since Sanguinetti's description[4] in 1934. This word denotes the presence of urea or of other nitrogenous bodies in the blood in abnormal amounts. Arguing from analogy to the commonly used term "alimentary hyperglycemia," it seems logical that the urea syndrome be termed "alimentary azotemia." The mechanism in both is the same, and the adjective differentiates both conditions from similar ones of different causation. Use of the designation "extrarenal azotemia" is not definitive enough. "Alimentary azotemia" means the azotemia due to ingestion of excessive proteins. In bleeding peptic ulcer it is probable that a large share of the resultant azotemia is alimentary azotemia due to ingestion of blood proteins; part of it may be due to other types of extrarenal azotemia, while in some instances actual renal azotemia may be a contributory factor.

SUMMARY AND CONCLUSIONS

1. The degree of alimentary azotemia (as evidenced by a rise in blood urea nitrogen) resulting from the administration of blood elements by stomach tube is altered by certain experimental manipulations on the circulation of the liver.

*These dogs were supplied to us through the courtesy of Dr. F. W. Hartman.

2. More specifically, the amount of elevation in the blood urea nitrogen level following the ingestion of whole blood or blood cells is greatest in animals with reverse Eck fistulas, is moderate in animals with both portal vein and vena cava ligated or in normal animals, and is inappreciable in animals with Eck fistulas or in those in which total hepatectomy has been done.

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CLINICAL STUDY OF RELATIVE EFFICIENCY FOR NITROGEN METABOLISM OF CASEIN DIGEST ADMINISTERED INTRAVENOUSLY AND PROTEIN INGESTED BY MOUTH*

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IT HAS been repeatedly demonstrated that casein digests may be administered intravenously with safety to man, and that by such means a negative nitrogen balance may be reduced, a nitrogen equilibrium maintained, and even a positive nitrogen balance obtained. The question of the efficiency in metabolism of nitrogen administered intravenously as a casein digest, as compared to its ingestion as protein by mouth, presents itself. For such study a group of postoperative patients who had undergone a variety of major intra-abdominal procedures were placed on nitrogen balance studies beginning the day after operation. Urine and feces were collected and total nitrogen loss determined, to be compared with nitrogen intake during each twenty-four hour period. During the initial period casein digest (Amigen) was administered daily together with dextrose. After four to six days, nitrogen balance studies continuing, a light diet was permitted by mouth, the daily protein content of which represented a quantity of nitrogen equivalent to the amount previously administered daily by vein as casein digest. The total caloric value of the diet by mouth (which included a small quantity of fat) was equivalent to the caloric value of the casein digest with glucose administered by vein. The calculated total caloric intakes usually varied from 780 to 1,200 calories.

In the interest of brevity the details of the total caloric intakes of each of the patients are not presented, suffice it to state again that for each individual patient these conditions were approximately uniform during the periods of parenteral nutrition and during the subsequent periods of nourishment by mouth. In a few instances the patients did not consume all of the diet on the first or second day when feeding by mouth was permitted. The nitrogen balances on such days, therefore, were not considered in the study; only those days where the full diet was consumed are taken into account.

The results of the nitrogen metabolism studies under these conditions are summarized in Table I. The patients presented are a selected group and are those in whom the postoperative course was essentially uneventful except for slightly elevated temperatures on the first two or three

*This study was conducted under a grant from Mead Johnson & Company, Evansville, Indiana.
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TABLE I

COMPARISON OF NITROGEN BALANCE IN POSTOPERATIVE PATIENTS DURING PERIOD OF NITROGEN NUTRITION BY VEIN (CASEIN DIGEST-AMIGEN) WITH PERIOD OF PROTEIN NUTRITION BY MOUTH

PATIENT	PERIOD OF INTRAVENOUS INJECTIONS OF CASEIN DIGEST				PERIOD OF NITROGEN INGESTION BY MOUTH AS FOOD PROTEIN			
	NO. OF DAYS	TOTAL N INTAKE (GM.)	TOTAL N EXCRETION (GM.)	AVERAGE DAILY N BALANCE (GM.)	NO. OF DAYS	TOTAL N INTAKE (GM.)	TOTAL N EXCRETION (GM.)	AVERAGE DAILY N BALANCE (GM.)
I (L.)	5	75.00	76.00	−0.20	4	60.00	56.56	+0.86
II (L.)	5	75.00	64.00	+2.20	5	76.00	43.40	+6.72
III (F.)*	4	60.00	61.94	−0.49	4	28.80	27.00	+0.45
IV (K.)	6	72.00	94.67	−3.72	6	72.00	62.14	+1.64
V (W.)	4	60.00	68.37	−2.09	4	60.80	61.85	−0.26
VI (C.)	5	45.75	48.70	−0.59	5	41.00	44.50	−0.70
VII (D.)	4	24.00	28.40	−1.10	4	23.20	31.00	−2.2
VIII (L.)	5	75.00	74.22	−0.16	5	75.00	49.21	+5.16
IX (H.)	5	36.00	32.34	+0.73	5	23.60	21.2	+0.48
X (C.)	5	15.00	66.16	−10.23	5	13.00	50.34	−7.47
XI (H.)	5	30.00	58.7	−5.74	5	26.28	40.74	−2.89
XII (M.)	4	48.00	46.88	+0.48	5	55.60	60.00	−0.88

*Total gastrectomy for carcinoma.

days postoperatively. This selection was necessary since where severe nausea and vomiting occur the nitrogen excretion might be inordinantly high; also, patients with moderate to high febrile reactions excrete relatively large quantities of nitrogen.

DISCUSSION

Among the twelve patients studied, three (II, IX, and XII) exhibited positive nitrogen balances during the injection period and in one (II) the positive balance was substantially greater when nitrogen was ingested by mouth as protein. In Patient IX the positive balance was less during the period of oral feeding but the total nitrogen intake was less than it was by vein. In Patient XII there was a slightly negative nitrogen balance on oral feeding as compared to a slightly positive nitrogen balance during the injection period.

In two patients (I and VIII) nitrogen equilibrium obtained during the injection period with slight positive balance in Patient I on oral feedings, and markedly positive nitrogen balance in Patient VIII during this period.

In two patients (III and VI) there was slight negative balance during the injection period, with slight positive nitrogen balance and nitrogen equilibrium, respectively, during the periods of oral feeding.

Two patients (V and VII) were in moderate negative nitrogen balance during the injection periods, and during the periods of oral feeding one (V) came into moderate positive nitrogen balance, while the other (VII) exhibited a greater negative balance.

Three patients exhibited rather pronounced negative nitrogen balances during the injection period (IV, X, XI), and during the oral feeding

period one (IV) was in moderate positive nitrogen balance, the second (X) remained in pronounced negative balance although less than during the injection period, and the third (XI) exhibited moderate negative balance, the total nitrogen intake, however, being appreciably less than that obtained during the injections.

It is noted that there was considerable variation in the results observed when comparing nitrogen balance during periods of nitrogen administration by vein as casein digest with periods when nitrogen was ingested orally as food protein. In most instances, however, the differences in the two periods were not pronounced. In the preceding patients the conditions of the experimental observations themselves favored a more pronounced negative nitrogen balance during the period which immediately followed operation and was the period during which injections of casein digest were carried out. Previously reported studies[1] on postoperative nitrogen loss have shown that this loss is much more pronounced during the first five days after operation. Thus, it could hardly be anticipated that nitrogen balance would be as favorable, under the aforementioned conditions of observations during the injection periods as during the periods of oral feedings. That the differences were, in general, not greater in favor of the efficiency of nitrogen metabolism when nitrogen was administered as food protein by mouth, attests to the efficacy of intravenous nitrogenous nutrition with casein digest.

It might appear superfluous in view of the classical biochemical and physiological teachings to demonstrate that intravenous nitrogenous nutrition by injection of amino acids (casein digest) approaches the efficiency of nitrogen utilization when taken by mouth as protein. However, until such studies were actually made in man and animals (the latter having been previously reported by others), the question of the existence of some unknown and important factor concerned with nitrogen assimilation and utilization in the wall of the alimentary tract could not be settled. It thus appears that such a factor does not exist.

SUMMARY

Data are presented to indicate that the efficiency in utilization of nitrogen administered intravenously as casein digest in man closely approaches the efficiency of utilization of nitrogen when ingested orally as food protein. The conditions of the clinical experiments recorded here favored, in themselves, a greater loss of nitrogen during the periods in which the digest was administered, as compared with the periods in the same patient when nitrogen was ingested as food protein.

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VARICOSE VEINS

A New Technique Resulting in the Rapid Obliteration of the Venous Channels Without the Formation of the Usual Large Thrombi

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PAST experiences in the management of the varicose veins in patients have created a desire to find some procedure that would give rapid complete obliteration of all venous channels without the usual large thrombi formation. Ligation and injection at the fossa ovalis in the usual manner resulted in incomplete thrombosis and large thrombi. Recurrences appeared in many cases. The following discourse is based upon a new compression bandage technique with the ligation of all the branches of the saphenous vein and the saphenous vein itself at the fossa ovalis together with low ligation and injection of the saphenous vein only at the low level.

Between October, 1942, and May 15, 1943, 299 patients have been observed. Disposition was recommended according to Table I.

One hundred forty-one patients have been operated upon, and of these, 105 cases have been carefully followed.

The incidence of varicose veins according to age and sex is shown in Table II.

Anatomically there are three systems of veins in the thigh and leg, namely, the internal or long saphenous, the external or short saphenous, and the femoral or deep venous system. In reference to varicosities there is a fourth group which cannot be ignored. This group of veins we call the subcutaneous veins, made up of segmental veins which may

Table I

	PATIENTS	PER CENT
Reclassification without treatment because of other defects	5	1.7
No treatment needed	31	10.4
Certificate of disability for discharge because of other diseases	5	1.7
Injection treatment only	59	19.7
*Advised to seek separation from service W.D. Cir. No. 397	37	12.3
Operation advised	162	54.2
Total	299	100.0

*War Department authorizing discharge of inductees above 38 years of age who were engaged in essential war industries prior to induction.

*Major, U. S. Army.

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TABLE II

AGES	PATIENTS	PER CENT	M	F
Between 19 and 20	2	1.9	2	0
Between 21 and 25	24	22.86	24	0
Between 26 and 30	35	33.33	34	1
Between 31 and 35	24	22.86	24	0
Between 36 and 40	10	9.52	10	0
Between 41 and 45	9	8.59	9	0
Between 46 and 50	1	0.95	1	0
Total	105	100.0	104	1

*One on the basis of psychoneurosis and the other because of severe bronchial asthma.

communicate with the long saphenous system at different points or may communicate in segmental fashion between the superficial branches of the long and short saphenous systems. The important point is that upon complete obliteration of the circulation in the long and short saphenous systems of the patient with varicose veins, these segmental subcutaneous channels with their varicosities may persist and vice versa.

These segmental subcutaneous varicose veins, however, are most amenable to injection treatment alone, because they communicate only indirectly with the main saphenous systems and are not a direct part of these systems per se.

Injections of sclerosing fluid into the varicosities of either the long saphenous or short saphenous system without ligation are almost sure to result in poor response or complete failure.

Mild varicosities of the internal or external saphenous system per se need no treatment and cause no symptoms. Appearance is the only indication of their presence. However, even mild varicosities of the subcutaneous group may produce sensations of prickling, discoloration, and even pain by forming small thrombi. Injection alone will secure excellent results in this small group, but will not eradicate the varicosities of the internal and external saphenous system.

Varicosities that are large, tortuous, ectatic, and producing symptoms of fullness in the veins and legs, leg fatigue, cramps in muscles, thrombi in segments, pains and cramps during or following long marches or upon standing at attention for long intervals, discoloration of the skin with suspected or impending ulceration, should be treated by active surgical and injection procedures.

Table III illustrates the incidence of varicosities according to legs involved.

TABLE III

	PATIENTS	PER CENT
Right leg	75	72.4
Left leg	66	62.8
Bilateral	36	34.3
Unilateral	69	65.7

Table IV illustrates the incidence of varicosities according to systems.

TABLE IV

	PATIENTS	PER CENT
Internal saphenous unilaterally	69	65.7
Internal saphenous bilaterally	36	34.4
Internal plus external saphenous	16	15.2
External saphenous only	4	3.8
Subcutaneous veins needing injection	26	24.7

The treatment of choice is one that will give complete thrombosis with elimination of the circulation throughout all varicosities, and is of such a nature that it is without untoward effects.

Another important point in treatment, especially in this group, is to accomplish the complete obliteration of the varicosities in the shortest time to be consistent with saving man power for the fullest expression of the war effort. Every soldier with varicosities producing symptoms that warrant operative intervention is potentially a candidate for reclassification to limited service or for a certificate of disability for discharge. Table V shows the ultimate disposition of cases in which operation was done.

TABLE V

	PATIENTS	PER CENT
Reclassified to limited service	17	12.05
Returned to full duty	122	86.53
*Certificate of disability for discharge	2	1.42
Total	141	100.00

*One on the basis of psychoneurosis and the other because of severe bronchial asthma.

The following procedure has been used uniformly in 141 patients with sustained excellent primary results, and without untoward effects.

A careful history is taken as to symptoms, duration, previous serious illnesses or operations, attacks of pain or swelling of the legs, with or without edema, and previous treatment, if any. One patient had as many as eighteen injections into the main saphenous systems without improvement.

To establish evidence of whether the varicosities are in the internal or external saphenous system per se or are of the subcutaneous type, or to establish evidence of adequate deep circulation without segmental or extensive thrombophlebitis these steps are taken with the patient standing, bearing equal weight on both feet: observation, palpation, percussion of venous channels, percussion of venous channels along with palpation, the application of continuous point pressure over venous channels with leg elevated and then with patient standing; the Ochsner-Mahorner[1] various level, comparative tourniquet test; and the Trendelenburg-Brodie test.

If the long saphenous system is at fault unilaterally or bilaterally, the saphenous vein is marked with 4 per cent gentian violet immediately over the fossa ovalis and again over the lower long saphenous vein in the thigh, just above the knee as shown (Fig. 1). If the short saphenous vein is to be ligated or if a segmental vein is to be ligated and injected, it is marked in like manner. If the patient is scheduled for operation, the leg is shaved widely around the operative sites the night before. He eats breakfast as usual the following morning, and no preliminary sedation is used because these patients must get up and walk postoperatively from the operating table to the stretcher, a distance of at least fifteen feet, because early and continuous walking obviates saphenous vein stump thrombosis.

Fig. 1.—The leg is shown marked with gentian violet over the internal saphenous vein at the fossa ovalis and at the lower thigh; wrapped with the rubber bandage and in position on the operating table.

Upon being placed on the operating table, the leg is held up in nearly perpendicular position, and all varicosities emptied of blood as completely as possible. Massage from the foot toward the body is used if necessary to collapse them. While the leg remains in an elevated position, a compression bandage 2 inches wide and 12 feet long of the ACE type, or better a pure, all rubber bandage (Davol) 2½ inches wide and 12 feet long is snugly wrapped from foot to knee, the end being tucked under the last turn so that it can be easily released. Another bandage is begun just above the operative site on the lower thigh and is carried to the groin.

The leg is now placed on the operating table with the knee elevated slightly on a sandbag as shown (Fig. 1). The groin and unwrapped thigh area are painted with tincture of iodine. The iodine is thoroughly

dried by fanning with a towel before the leg is draped. The gentian violet marks are still plainly visible as the iodine does not remove them.

The line of incision through the skin and parallel to the fold in the groin as previously marked is inflated with 5 c.c. of 1 per cent novocain using a small hypodermic needle. Ten cubic centimeters of 1 per cent novocain are infiltrated through a No. 22 gauge three-inch needle into the subcutaneous tissue and injected toward the incoming nerves above. Five cubic centimeters of 1 per cent novocain are deposited directly over the femoral artery and vein. Withdrawal of the plunger before injection of novocain precludes possible introduction into blood vessels. This area is then massaged with a dry sponge to cause better diffusion of the anesthetic solution.

An incision of 1½ to 2 inches in length, parallel to the skin fold, is made just through the skin. By careful dissection the superficial tissues are separated and the saphenous vein with all of its branches is dissected and identified. The branches are doubly ligated with cotton and severed between the ligatures. Four ligatures of cotton are placed on the saphenous vein, the uppermost one being above the pudendal branch and the two lower ones as far distal as possible. The smallest size cotton thread adequate for ligation of the vessels concerned should be used. No. 40, 30, 20, and 8 cotton have been employed. The section of vein in between is removed; the superficial fascia closed with interrupted sutures of No. 50 cotton and the skin with interrupted sutures of No. 20 or No. 8 cotton.

In no patient is sclerosing fluid injected at the upper thigh level at the time of operation. Thrombosis occurs in these segments in almost every instance. If thrombosis has not occurred within two weeks following operation, 5 c.c. of sodium morrhuate are injected. This was necessary in less than 5 per cent of the patients in this series.

The foot and leg drape is now moved down to the lower level. The skin is infiltrated with 2 c.c. of 1 per cent novocain, and 2 c.c. are injected deeply on each side of the vein. A transverse incision is made, and by careful dissection the saphenous vein is elevated. Two ligatures of cotton are placed around the proximal portion and a loose ligature of cotton is placed around the distal portion. The vein is cut in half transversely, lying on a small clamp while a gentle pull is made by the assistant on the loose ligature. A cannula made of a No. 19 gauge needle filed smooth at its point is inserted, attached to a 10 c.c. syringe carrying 5 c.c. of 5 per cent sodium morrhuate with 2 per cent benzyl alcohol. The loose ligature is tightened so that the cannula is fixed in the lumen and no leakage of sclerosing fluid will occur. While the cannula is held steady, an operating room attendant begins to unwrap the bandage from the knee toward the foot. As the leg is unwrapped, the sodium morrhuate is injected so that when the last turn is off, the last of the sclerosing

fluid is injected into an empty or nearly empty venous system. Rapid removal of the bandage is desired. The cannula is withdrawn, the ligature tightened, and a second ligature placed on the distal end before the vein is severed. If there is duplication of the saphenous vein, both are injected and ligated. The drapes are removed and the remaining bandage removed from the thigh.

If there are any long subcutaneous tributary veins present at this lower level they are also ligated but not necessarily injected. Ligation at the lower thigh level is done in every instance regardless of single or double positive Trendelenburg test, and even though the Ochsner-Mahorner test shows no communicators with incompetent valves. This low level ligation is necessary to accomplish the desired effect of the sclerosing fluid on the intima of the empty veins, and it also seems desirous to interrupt permanently the continuity of this long venous channel.

Small sterile dressings are placed over the wounds and fixed with adhesive tape. It is very desirous that small dressings be used as they do not interfere with the patient in walking.

The patient immediately sits on the side of the operating table, gets off and walks to the stretcher, a distance of fifteen feet. When he arrives at the ward he must walk every thirty minutes during the rest of the day. If he awakes at night, he is asked to get up and walk. The second day he walks about the ward at least every hour and the third day he is encouraged to walk at frequent intervals and to walk to the mess hall.

Within twenty-four to forty-eight hours following operation the sclerosing fluid, which has penetrated the furthermost ramification of the varicosities in the internal saphenous system of the lower leg, has caused red or slightly brownish streaks to appear along the varicose channels. The varicosities do not refill with blood, and the large thrombi seen before the use of the compression bandage technique are not present. It would appear that this phenomenon is due to the constricting action of the sclerosing fluid as it comes in contact with the intima of the empty vein into which it is injected. It also seems plausible that the smaller the thrombi, the less the discomfort and the quicker the patient's leg returns to normal condition. This has certainly been our experience.

This same method of procedure is applicable to treatment of the short saphenous vein in which case it is only necessary to wrap the rubber bandage over the lower leg. Segmental subcutaneous veins for ligation and injection can also be emptied by use of the bandage.

Thrombosis readily takes place in the thigh varicosities due to the ligation alone. In some cases thrombosis occurs as rapidly as in the veins which have received the sclerosing fluid and again it may be two weeks before the thrombus forms.

In the dissections of the saphenous vein at the fossa ovalis we have seen the anatomic variations of all type, as have been so adequately described by Glasser.[2]

The average period of hospitalization is fourteen days, at the end of which time these patients return to regular duty.

Evidence to substantiate the clinical experience was sought by roentgenographic studies of the varicose veins when injected with x-ray opaque diodrast.

Five cubic centimeters of diodrast were injected into the internal saphenous system at the lower thigh while the internal saphenous vein was full of blood as the leg lay in the horizontal position on the operating table. A roentgenogram was made thirty seconds later and it shows stagnation of the diodrast in the upper segment of the vein (Fig. 2a, *A*).

The leg was then elevated and wrapped with the compression rubber bandage from the foot to the operative site at the lower thigh. Another roentgenogram was taken to show that all the diodrast was extruded from the system (Fig. 2a, *B*). Now as the rubber bandage was removed from the thigh toward the foot, 5 c.c. of diodrast were injected and thirty seconds later another roentgenogram was taken showing the dissimination of this, an equal volume of diodrast into the distal most ramifications of the varicosities (Fig. 2b, *A*). The other view (*B*) in Fig. 2b shows the diodrast still present three minutes later.

Another patient was studied and again 5 c.c. of diodrast were injected into the internal saphenous system at the lower thigh while the internal saphenous vein was full of blood as the leg lay in the horizontal position on the operating table. A roentgenogram was made thirty seconds later and it shows stagnation of the diodrast in the upper vein segment (Fig. 3a, *A*). Another roentgenogram was made three minutes later to determine if after a time interval there was better dissimination, but none occurred (Fig. 3a, *B*).

The leg was then elevated and wrapped with the compression rubber bandage from the foot to the operative site at the lower thigh. Now again as the rubber bandage was removed, 5 c.c. of diodrast were injected and thirty seconds later another roentgenogram was taken showing the dissimination of the diodrast into the ramifications of the varicosities (Fig. 3b, *A*). Three minutes later another roentgenogram was taken and the diodrast was still prominently visible (Fig. 3b, *B*).

One must conclude that an equal volume 5 c.c. of sodium morrhuate would and does likewise dissiminate into the most distal varicosities of the system injected and therefore causes more complete obliteration of that system.

The maximum amount of sodium morrhuate injected into any one vein is 5 c.c. and the maximum amount given to any one patient at any one time, even in bilateral long saphenous ligation together with single

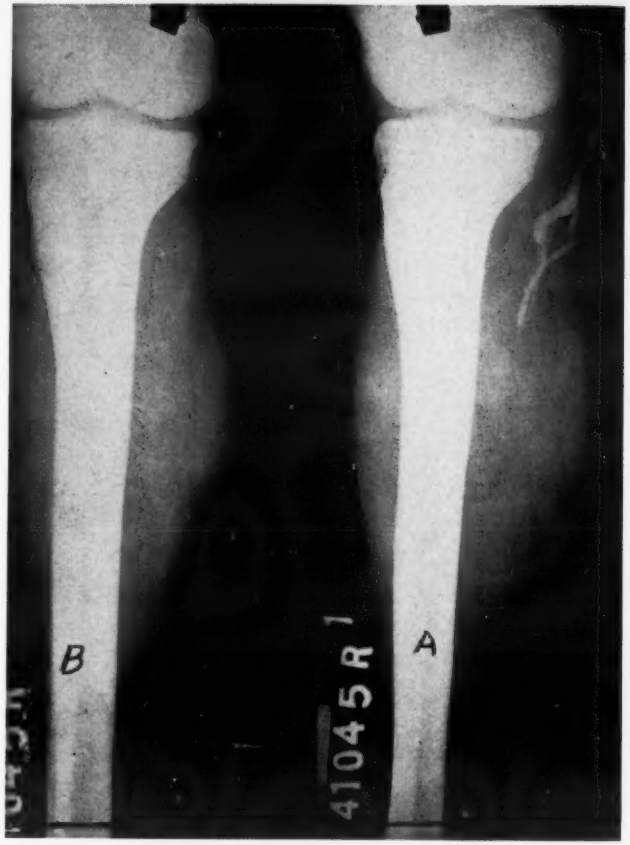

Fig. 2a.

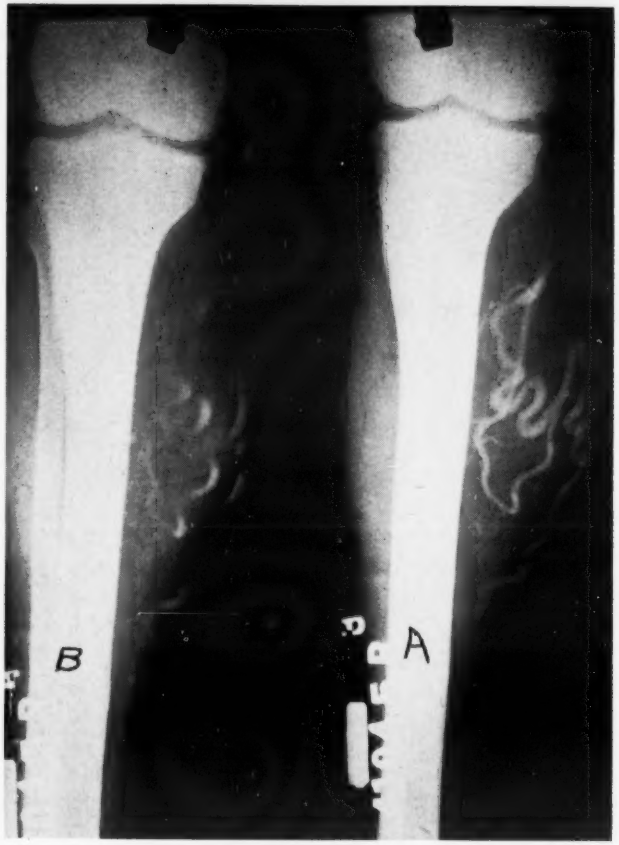

Fig. 2b.

Fig. 2a.—Patient C. J. S. *A*, On the right, shows stagnation of the diodrast in the upper vein segment. *B*, On the left, shows all diodrast expelled before the second injection of 5 c.c. is done.

Fig. 2b.—Patient C. J. S. *A*, On the right, shows the dissemination of 5 c.c. of diodrast when injected using the rubber bandage technique. *B*, On the left, shows the diodrast three minutes later still visible.

Fig. 3a.

Fig. 3b.

Fig. 3a.—Patient W. H. *A*, On the right, shows stagnation of 5 c.c. of diodrast in the upper vein segment. *B*, On the left, three minutes later, shows only small amount of diodrast present.

Fig. 3b.—Patient W. H. *A*, On the right, shows the dissemination of 5 c.c. of diodrast when injected using the rubber bandage technique. *B*, On the left, three minutes later, shows the diodrast still prominently visible.

short saphenous ligation, is 12 c.c. These amounts produce adequate thrombosis.

There have been no systemic reactions, such as anaphylaxis, coughing, nausea or vomiting, pallor or fainting. Local reactions, severe in some cases, manifested by red streaks along veins, erythema, and edema, all have subsided and disappeared within seven to ten days. Small hard thrombi remain as evidence of the original varicosities, and these are absorbed only after months have passed.

Fig. 4, *A* and *B*.—Patient R. P., aged 25 years. This patient had varicose veins bilateral, involving the internal saphenous veins bilaterally and the right external saphenous system.

C and *D*.—Showing end result four months later following bilateral ligations at the fossa ovalis and at the lower thighs with injections of 5 c.c. sodium morrhuate into each long saphenous vein and ligation of the right external saphenous vein with injection of 4 c.c. sodium morrhuate. This patient has continued to remain on full military duty status and marches 12 miles without discomfort.

Fig. 5.—Patient S. De G., aged 36 years. *A*, Shows bilateral varicosities of the internal saphenous systems plus subcutaneous segmental varicosities of the left leg behind the knee. *B*, Shows the patient three days following bilateral ligations at fossa ovalis and at lower thighs with bilateral injections of 5 c.c. sodium morrhuate, and also ligation and injection of 3 c.c. sodium morrhuate in subcutaneous vein. Note absence of large thrombi.
C.—Showing the patient four weeks postoperatively.

Only two wounds have broken down in the region of the groin, both because of hematoma formation, and both promptly healed following evacuation of clots and warm saline dressings.

Only two patients have shown mild persistent edema of the leg, and this only over the tibia.

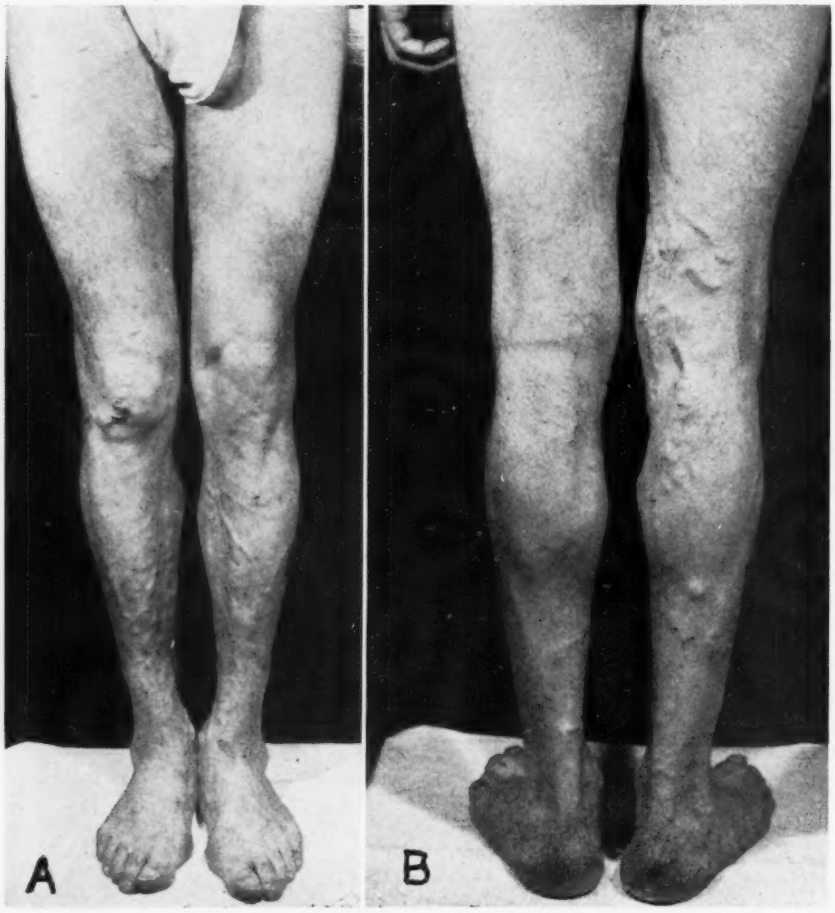

Fig. 6, *A* and *B*.—Patient W. G., aged 35 years. Showing varicose veins of internal saphenous systems bilaterally.

SUMMARY

1. One hundred forty-one cases of varicose veins are reported. All those involving the long saphenous were treated by uniform ligation of all its branches and the saphenous itself at the fossa ovalis without injection of sclerosing fluid into the thigh, together with ligation and injection of the internal saphenous at the lower thigh.

2. It is believed that complete emptying of the veins by compression bandages of the ACE or rubber type is a distinct advantage in reducing the size of the thrombi and insures better diffusion of the sclerosing fluid into the most distal ramifications of the varicosities.

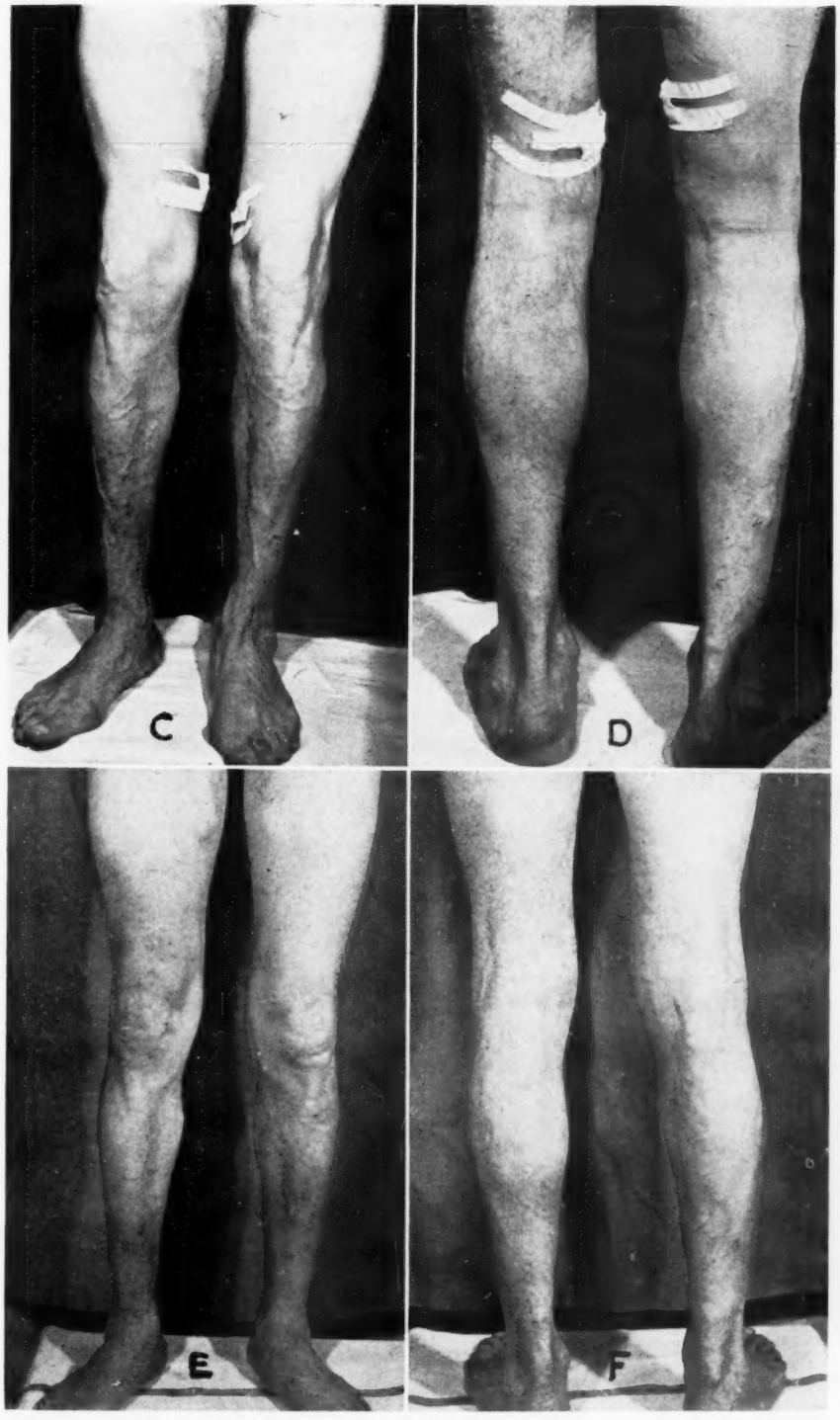

Fig. 6, *C* and *D*.—Showing almost complete obliteration of all varicosities three days following bilateral ligations at the fossa ovalis and at the lower thigh with bilateral injection of 5 c.c. sodium morrhuate; note absence of large thrombi.

E and *F*.—Showing patient fourteen days postoperatively with complete obliteration of the varicosities.

3. Five cubic centimeters of sodium morrhuate produce excellent thrombosis in varicosities of the lower leg and this is the maximum amount used in any single vein.

4. It would appear that this technique yields a complete obliteration of all varicosities without untoward manifestations.

5. No recurrences have been noted but it is unquestionably too soon to estimate this phase of the subject. It is hoped that a supplementary report may be made in the future.

The author would like to acknowledge the cooperation of Colonel Lucius F. Wright, Station Hospital; Lt. Colonel A. Scott Hamilton, Surgery Division; Lt. Colonel P. V. McCarthy, x-ray department; Sergeant Leonard Ingber, who made the photographs, and the entire surgical staff in the preparation of this paper.

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SYNTHETIC VITAMIN K AND THE THROMBOSIS OF VEINS FOLLOWING INJURY

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VITAMIN K is used widely in certain surgical patients to combat a bleeding tendency and in parturient women to prevent hemorrhagic disease of the newborn. Both surgical patients and parturient women are particularly susceptible to thrombosis and thrombophlebitis, although the use of vitamin K does not appear clinically to increase their susceptibility. The following study was made of a group of patients and of a series of experiments with animals to determine what influence, if any, the use of vitamin K might have on thrombus formation.

The suggestion of the relationship of hemorrhagic diathesis to a deficiency of the fat-soluble vitamin K, in 1929,[1] and later in 1934,[2] by Dam, stimulated great interest in this new vitamin. Vitamin K is concerned with the production of plasma prothrombin which is involved in the mechanism of the clotting of the blood. In animals, prolongation of the prothrombin time with accompanying bleeding has been observed in chicks after the withdrawal of the vitamin from the diet, and in cattle with sweet clover disease. In man, a lowered blood prothrombin with its bleeding accompaniment has been observed in hemorrhagic disease of the newborn, obstructive jaundice, severe liver damage, and in chronic gastrointestinal diseases and conditions such as sprue, chronic ulcerative colitis, intestinal polyposis, and gastrocolic fistula. The attendant hemorrhages have been treated prophylactically and therapeutically in the last few years with vitamin K, with the addition of bile salts in the jaundiced patient. Doisy and his associates[3] have been mainly responsible for the synthesis of vitamin K, the compound being 2-methyl-1,4-naphthoquinone.

Waddell, Guerry, and Birdsong[8, 9, 10] have made a study of prothrombin deficiency in infants in this hospital and have obviated hemorrhages in the newborn infants by administering vitamin K concentrate and synthetic vitamin K to infants in the first few days of life, and to mothers in the last two weeks of pregnancy.

No observer so far has reported an increased incidence of thrombosis or thrombophlebitis in patients treated with vitamin K. In the University of Virginia Hospital, at the time this investigation was commenced,

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both the natural and synthetic vitamin K complex had been administered orally and intravenously to 700 pregnant women during the antepartum period with only one case attended by thrombophlebitis, and that following a Porro section, performed because of fibroids of the uterus complicating the delivery. The incidence of thrombophlebitis in this group of 700 was, therefore, only 0.14 per cent. In the preceding ten years without vitamin K there had been 5,728 deliveries with twenty-eight cases complicated by thrombophlebitis during the puerperium. Almost one-half of these cases had had some accompanying operative procedure, such as a Cesarean section, Porro section, or sterilization. The incidence of thrombophlebitis in this group was 0.48 per cent. Consequently, the incidence of thrombophlebitis was greater in the larger group receiving no vitamin K, other than that obtained in the average diet (Table I).

EXPERIMENTAL METHODS

The plan devised was to traumatize mechanically the leg veins of two groups of dogs. The first group was to be fed an excess of vitamin K in addition to a normal diet. The second, the control group, was to receive the diet alone.

Mongrel dogs weighing nine to forty-two pounds were used and were fed a normal diet throughout. Twenty-five dogs were used as controls and twenty-seven dogs were given vitamin K, 3 mg. of 2-methyl-1,4-naphthoquinone* per dog per day during the entire experiment. Prothrombin determinations by the Quick method[5, 6] and hematocrit determinations were made on all the dogs before the start of the investigation and at the end of one week. In some of the animals clotting times were made by placing about 1 c.c. of venous blood gently in a glass-stoppered

TABLE I

INCIDENCE OF THROMBOPHLEBITIS IN PARTURIENT WOMEN IN THE UNIVERSITY OF VIRGINIA HOSPITAL

GROUP	NO. OF DELIVERIES	CASES OF THROMBOPHLEBITIS	PER CENT OF THROMBOPHLEBITIS
Vitamin K	700	1	0.14
Control	5,728	28	0.48

weighing dish, and recording the time of clot formation. On the eighth day of the experiment, the radial and saphenous veins of the four legs of both the experimental and control groups of dogs were treated in the following manner. Pressure was applied to the limb proximally to engorge the vessel. A No. 15 intravenous needle was then introduced well into the lumen of the vein after which a No. 22 spinal needle with a slight "hook" on the tip was inserted, through the larger needle, farther into the vein. The vein was then collapsed by releasing the pressure and

*Part were given Abbott's synthetic preparation in sesame oil, part Squibb's synthetic preparation in corn oil.

both needles withdrawn together by a rotary motion so as to tear slightly the intima throughout, approximately 6 to 8 cm. of the length of the vessel. The amount of trauma was in all instances made as uniform as possible. The site of insertion of the needle and the level to which it was introduced in the vein was then marked by tatooing the leg.

Under general anesthesia with Abbott veterinary nembutal given intraperitoneally and intravenously (1 c.c. per 5 pounds), at approximately forty-eight hours after the traumatizing procedure described, the veins were removed by surgical excision from ten control dogs and from ten dogs treated with synthetic vitamin K. Care was taken to avoid trauma at the time of removal. At ninety-six hours veins were removed from the legs of fifteen dogs of the control group, and from seventeen dogs of the vitamin K group. Prothrombin times, hematocrit determination, and, in some, clotting times were repeated on all dogs immediately before operation.

Each of the excised veins were fixed in 10 per cent formalin before sectioning. Four sections were taken from each vein at various levels. They were processed in the usual manner, mounted in paraffin, and stained with hematoxylin and eosin.

RESULTS

In some instances the initial venipuncture was unsatisfactory and consequently these vessels were not included in the study. The stained sections of all veins were studied alone and by a pathologist who in no instance knew whether he was dealing with experimental or control material. Only those vessels showing subtotal or total occlusion of the lumen were adjudged thrombosed. Some veins had a minimal amount of fibrin deposited at the puncture site and were excluded from the group of thrombosed veins. There was no significant difference between the incidence of thrombosis in the animals at forty-eight and ninety-six hours after trauma.

The incidence of thrombosis in the animals which were used as controls was twenty-nine out of eighty-nine veins, or 33.0 per cent. In the vitamin K group there were thirty-seven out of ninety-seven veins or 38.0 per cent (Table II). There was no significant difference in the incidence of thrombosis in those receiving Squibb's synthetic preparation of vitamin K in corn oil, and those receiving Abbott's synthetic preparation of vitamin K in sesame oil.

The prothrombin time of all the animals, both before and after ad-

TABLE II

COMPARISON OF RESULTS IN THE GROUP OF DOGS GIVEN VITAMIN K AND THE GROUP USED AS CONTROLS

GROUP	NO. OF VEINS	POSITIVE FOR THROMBOSIS	PER CENT OF POSITIVES
Vitamin K	97	37	38.0
Control	89	29	33.0

ministration of vitamin K, was well within normal limits. In the group fed vitamin K the average prothrombin time before the start of the experiment was 6.6 seconds, and the average on the eighth, tenth, and twelfth days was 6.3 seconds.

Hematocrit determinations revealed no significant change in the relative erythrocyte volume during the period of experimentation. In the six dogs in the vitamin K group having one or more hematocrit readings below 40 per cent, the incidence of thrombosis was 62.0 per cent. In the five dogs of the control group with a reading below 40 per cent, the thrombosis rate was 44.0 per cent (Table III). This is in agreement

TABLE III

RESULTS: INCIDENCE OF THROMBUS FORMATION IN THE DOGS HAVING ONE OR MORE HEMATOCRIT READINGS BELOW 40 PER CENT

GROUP	NO. OF VEINS	POSITIVE FOR THROMBOSIS	PER CENT OF POSITIVES
Vitamin K	21	13	62.0
Control	18	8	44.0

with the findings of other workers from the time of Welch,[11] who found an increased thrombosis rate in patients with anemia, deficiency states, and cachexia.

A few clotting times were well above normal, but most of these were in those dogs which were under anesthesia, which will increase the clotting time of the blood. The average clotting times of the unanesthetized dogs were within the normal range without marked variation, varying from 6.1 to 8.9 minutes on the various days. In the anesthetized groups the average varied from 8 to 11.4 minutes.

DISCUSSION

The foregoing experiments were undertaken in the belief that synthetic vitamin K would probably not influence the incidence of thrombosis in a group of normal dogs which had been and were on an adequate diet, and whose prothrombin times indicated a normal plasma prothrombin. Since the normal animal has a large excess of prothrombin which far exceeds the physiologic requirements, and at least 80 per cent may be lost before the coagulation time is greatly prolonged,[7] feeding vitamin K to a normal animal should not appreciably alter the prothrombin time and concentration. Actually, feeding synthetic vitamin K for at least a week or more was found to lower the average prothrombin time only 0.3 second, which is within the limits of experimental error.

The slight difference in the incidence of thrombosis between the control and experimental groups of dogs is probably of no significance. The thromboplastin, calcium, and fibrinogen factors which are essential to the clotting process were presumably equal in the two groups, and the prothrombin factor was found to have essentially the same normal value

in the control group and vitamin K group before and after feeding vitamin K.

Clinically, vitamin K has proved efficacious in the prophylactic and therapeutic treatment of hemorrhagic diathesis of the newborn infant, with no increase in the number of thromboses. The incidence of thrombophlebitis in only one of 700 pregnant women given vitamin K in its various forms, orally and intravenously, as prophylaxis against hemorrhagic disease in the infant was 0.14 per cent over a period of two years. In 5,728 women delivered but not given vitamin K in a preceding ten-year period, there were twenty-eight cases of thrombophlebitis or an incidence of 0.48 per cent.

As shown by Norris and Bennett,[4] the average plasma prothrombin values of mothers at delivery are greater than normal controls, being 111 per cent. This may contribute to the slightly increased incidence of thrombophlebitis in parturient women.

SUMMARY

A group of experiments performed to study the possible influence of vitamin K on thrombus formation in dogs has been described. The radial and saphenous veins of the legs of fifty-two dogs were traumatized mechanically by scarifying the intima with a hooked needle. The veins were removed at forty-eight and ninety-six hour intervals afterwards. Twenty-seven of the animals received a surplus of synthetic vitamin K along with the regular diet for a week prior to the injury, and the remaining twenty-five were utilized as controls. Prothrombin times, hematocrit determinations, and clotting times were made in each animal at intervals, without any demonstrable effect of synthetic vitamin K administration.

The incidence of thrombosis after injury to the intima of the veins was not significantly increased coincident with the administration of synthetic vitamin K, being 33.0 per cent in the control group and 38.0 per cent in the vitamin K group. The small difference does not seem important. The prothrombin values, which are important in the coagulation process, did not significantly change after the administration of synthetic vitamin K. There was no significant difference in the results obtained by the Squibb and Abbott synthetic preparations. Those dogs with a hematocrit reading below 40 per cent, however, revealed a slightly higher incidence of thrombosis in both the control and vitamin K fed group.

Clinically, the incidence of thrombophlebitis has been less in the University of Virginia Hospital in the smaller group of women given vitamin K just before or at the time of delivery than in the larger group receiving no exogenous vitamin K except in the normal diet.

CONCLUSIONS

The clinical and experimental data reported demonstrate that an excess of vitamin K does not result in an increased rate of thrombosis.

We wish to express appreciation to Dr. J. K. Scott, Department of Pathology, for valuable aid rendered in microscopic study of the tissues, and to Dr. K. B. Grim, Department of Clinical Pathology, for making the prothrombin and hematocrit determinations.

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ACUTE DIVERTICULITIS OF THE JEJUNUM—CASE REPORT

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IN THE course of surgical operations requiring an inspection of the stomach and upper gastrointestinal tract I have encountered both single and multiple diverticula of the jejunum on fairly numerous occasions.

Previously, in no instance, either pre- or postoperatively, had this condition given rise to any symptoms. Recently, a Costa Rican farmer was admitted to the surgical service of Gorgas Hospital with a diagnosis of acute surgical abdomen. A definite preoperative diagnosis could not be arrived at, and an exploratory laparotomy revealed that he was suffering from an acute diverticulitis of the jejunum. Due to the rarity of this condition, the following case is reported.

E. C., aged 56 years, was admitted to the hospital Dec. 19, 1942. The chief complaint was agonizing colicky pain in the upper abdomen, and vomiting of three days' duration. The onset of this illness had been three days previously with acute colicky pains in the epigastrium. The pain was intermittent in character, and so severe that he was doubled up with each seizure. The pain increased in severity and remained in the epigastric region. There was no radiation of the pain. It was increased by deep breathing. No position accorded any relief. Nausea and vomiting were present for three days. The vomitus was yellow in color. There were no chills nor fever, no jaundice, no clay-colored stools, no tarry stools. When asked why he came to the hospital he replied that he was brought by his family against his will; pain was so severe he thought he would surely die.

Past History.—For two months prior to this attack he had been having slight, dull aching pains in the epigastric region about thirty minutes after meals. All types of food caused pain.

Physical examination revealed an acutely ill, thin, dehydrated mestizo man, lying in bed with both lower extremities flexed on the abdomen. He held his upper abdomen with both hands crying out with each paroxysm of pain. Temperature was 99.6° F., pulse 90, respiration 20. Skin was dry; there was no jaundice. Head and neck were normal, as were heart and lungs. Blood pressure was 130/54. Abdomen was flat, with no distention; it was held rigid. The respirations were thoracic. Palpation revealed generalized spasticity and rigidity, most marked in the upper abdomen. The point of maximum tenderness was in the midepigastrium just to the right of the midline. The liver could not be palpated and no abdominal masses were palpated. There was no tenderness to deep percussion over the kidney regions. Peristalsis was slightly increased. The genitourinary system was normal; neurologic system was normal.

Laboratory Findings.—Hemoglobin was 70 per cent; red blood cells 4,000,000; white blood cells 24,600; polymorphonuclear neutrophil leucocytes 93 per cent; eosinophiles 2 per cent; lymphocytes 5 per cent. Thick and thin smears for malaria were negative, Kahn test was negative, and urinalysis normal. X-rays of the chest were

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negative. There was no air underneath the diaphragm. A flat plate of the abdomen was negative and no renal or biliary calculi were seen.

A tentative diagnosis of acute cholecystitis was made and the patient was given ¼ gr. of morphine and 1000 c.c. of 5 per cent glucose in normal saline solution. Three hours later his condition was much worse. The pain in the epigastrium returned with greater intensity, it was now constant, he was unable to lie still, and rolled from one side of the bed to the other, crying out with the pain. The temperature rose to 101.2° F., pulse 110, respiration 24. The abdominal rigidity was now boardlike. The white blood cell count was repeated and was 49,100, polymorphonuclear neutrophil leucocytes 91 per cent, eosinophiles 2, and lymphocytes 7.

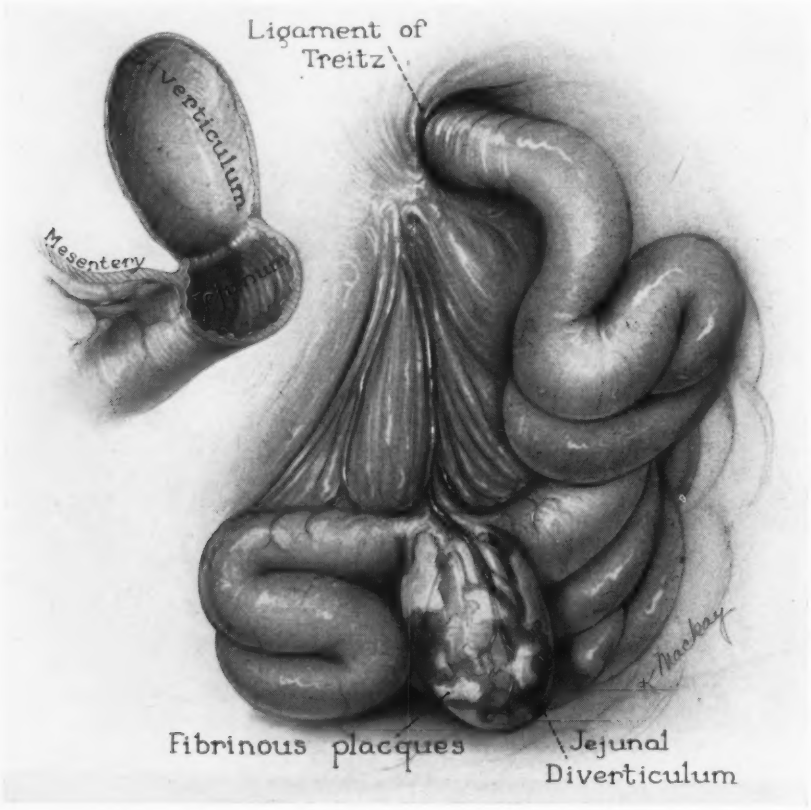

Fig. 1.

An exploratory laparotomy was done for perforation of the gall bladder. Under ether anesthesia an upper right rectus incision was made. On opening the peritoneal cavity there was a moderate amount of cloudy fluid. The peritoneum and serosa of the intestines were slightly injected. The gall bladder and bile ducts were normal. No gastric or duodenal ulcers were found. The pancreas was normal and appendix was normal. A search of the small gut revealed a large solitary diverticulum of the jejunum about eighteen inches from the ligament of Treitz (Fig. 1). It arose from the superior aspect of the jejunum about 1 cm. from the mesenteric border. It measured 2½ cm. at its base, 4 cm. in width, and 6 cm. in length. Its serosa was markedly injected, and scattered over its surface were numerous fibrinous placques, similar to the reaction seen in acute suppurative appendicitis. The walls of the diverticulum were slightly thickened, and its contents, mostly gas, were easily evacuated into the jejunum. Its base was clamped, and the diverticulum was removed.

The gross specimen showed rather marked reddening and congestion of the serosa. The wall was slightly thickened, the rugae of the mucosa were prominent. There was no ulceration or perforation. Microscopic examination showed hyperplasia of the jejunal mucosa. The lamina propria of the mucosa was markedly congested. A few of the vessels had ruptured, spilling blood into the interstitial tissue. The lamina propria in some areas was heavily infiltrated with plasma cells, eosinophilic leucocytes, a few small round cells, and a rare polymorphonuclear leucocyte. A slight subacute inflammatory reaction was noted within the submucosa. The serosal vessels were slightly congested. No evidence of malignancy or acute perforation was found.

The postoperative course was uneventful. The patient was discharged on the twentieth postoperative day. Re-examination eight months later, Aug. 13, 1943, showed the patient to be in excellent health. He had regained his original weight of 104 pounds. He has had no abdominal pain, he can eat any type food without discomfort. X-ray of the gastrointestinal tract was normal.

SUMMARY

1. A case of acute diverticulitis of the jejunum is reported.

2. Due to the rarity of this condition, it was thought advisable to include it in the literature.

TUMORS OF SALIVARY GLAND ORIGIN

So-Called Mixed Tumors

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Introduction.—Although "mixed" tumors of salivary gland origin are not uncommon, debate still rages about etiology, and to a lesser degree, about diagnosis, and treatment. This report by various members of the staff of the New York Post-Graduate Hospital, of fifty-six cases seen at this institution during eleven years from February, 1930, to February, 1941, may serve to clarify the problems of diagnosis and therapy.

Pathogenesis.—The pathogenesis of this group of tumors has been a controversial subject for many years. Maximow and Bloom, Arey, Zymbal, Li and Yang, and Sheldon have contributed to its study. Sheldon agreed with most authors that the cartilage-like cells, often so prominent a feature of the tumors, were in reality epithelial cells, but contended that true cartilage may be present, the latter arising, not from epithelium, but from the stroma itself. He regarded the neoplasms as composed of one or two different types of cells, both normally present in salivary glands; one is represented by secreting epithelium, and the other by the basket cells which are peculiar muscle cells belonging to the myoepithelium. Allen opposed his conclusions to those represented by Zymbal and by Sheldon. Working with four so-called mixed tumors from mammary glands of dogs and one from a human breast, Allen considered the "cartilage" in three canine cases to be true cartilage "derived directly from adult epithelium," and indicated that these conclusions were applicable to "mixed" tumors of the salivary glands.

Gross Anatomy.—Relatively few neoplasms of the salivary glands are clinically and microscopically carcinomas, and almost all are referred to as "mixed" tumors. The word "mixed" is placed in quotation marks because practically none are really mixed, in the sense of teratomas (ovary, testis, etc.) and refers to the fact that, in addition to the predominating epithelium, there is stroma with diverse features suggesting dysontogenesis.

"Encapsulation" is a term with various interpretations. The capsule of a salivary gland neoplasm bears no resemblance to the true capsule of the spleen or kidney. It consists of the more or less thickened pre-existent interlobular septa of the peripheral part of the gland. This means that, on the one hand, the "capsule" is intimately connected with

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the septa in the area of the tumor, and that, on the other hand, the "capsule" is also connected with the septa of the surrounding nonneoplastic portion of the salivary gland. As a result, when the neoplasm is "enucleated," nonneoplastic tissues are also removed as they lie outside the capsule of the tumor.

There are dilated neoplastic acini just inside and closely adherent to the capsule. If an attempt were made to remove the tumor without the capsule, the outermost walls of such tumor acini would be left behind to serve as the nidus for a so-called recurrence of the new growth.

Malignancy may manifest itself as extension of the neoplasm beyond the capsule, or, less commonly, by metastasis.

"Aberrant" cannot be applied to the neoplasms found in the mouth. Aberration of the normal process of development may be responsible for the presence of salivary gland tissues in structures adjacent to the oral cavity, including the base of the skull. The lobe of the ear is too close to the parotid gland to be considered a significant aberrant site. A few tumors similar to the so-called aberrant tumors have been found elsewhere in the body, as, for example, on the leg. The close resemblance between cutaneous basal tumors and salivary gland tumors suggests that such neoplasms of the extremities are probably extreme variants of basal cell carcinoma.

The surface of the salivary gland tumor is frequently nodular because the neoplastic process involves many lobules. The cut surface is usually lobulated, light gray to yellowish gray, and often has mucoid or glassy areas. The latter are foci of cartilage-like stroma, which however, rarely cut with the resistance of true cartilage.

Microscopic Anatomy.—Microscopically, the predominant element is the epithelium which appears in the form of interlacing strands, convoluted columns, solid nests, cribriform nests, acini, etc. Impressive evidence, including that provided by tissue culture, has been marshalled by Zymbal to indicate that the neoplasms are not mixed. His work tends to show that the mucoid portions of the stroma are due to degeneration and subsequent disintegration of the epithelium. The so-called cartilage is, therefore, not cartilage but altered stroma that suggests but does not have the features of true cartilage.

Other changes in the stroma include hyalinization (frequently a prominent feature), calcification, and even ossification. Fat is sometimes found. Many salivary gland tumors do not have the cartilage-like areas in conspicuous fashion, so that unless several sections are examined the microscopic picture may look like that of an adenoma, a relatively rare salivary gland tumor.

Site.—There were 56 mixed tumors of the salivary gland region in 55 patients. One patient had two distinct tumors, one of the soft palate and another of the parotid gland. The tumor of the soft palate was completely removed and seven years later a tumor of the parotid gland

was noted and removed; neither has recurred. Of the 56 tumors, 32 were in the parotid, 3 in the submaxillary, and 1 in the sublingual gland. Twenty others, not connected with the large glands, were found in various parts of the head. Eight were in the hard palate, 2 in the upper lips, 2 in the lower lips, and 2 in the cheek. There was 1 each in the scalp, lobe of the ear, soft palate, nasolabial fold, infraorbital and postauricular areas. One tumor was found on the leg which microscopically closely resembled the neoplasms of this group, but it is not included in the statistical study.

Age and Sex.—Twenty-eight men and 27 women comprised the group reported here. The average age when the tumor was noted was 35 years. The youngest patient was 14 years of age and the oldest, 75 years; 79 per cent were under 50 years of age, and 50 per cent were between 21 and 40. In Wood's series of 42 cases, one-half of the number of patients were between 21 and 50 years of age. Chen and Loucks reported 45 cases of which 80 per cent of the patients were less than 40 years of age. McFarland collected 90 cases, more than one-half of which were in the third and fourth decades. His youngest patient was 1 year old, and his oldest, 75 years.

The youngest patient coming to operation was 16 years of age and the oldest, 76 years; the average age was 43.4 years. Two-thirds of the patients were operated upon during the third, fourth, and fifth decades.

Duration.—A characteristic feature of this group of tumors is the long lapse of time before operation. One patient had noticed a mass for 34 years before coming to the hospital. Benedict and Meigs described a tumor that had been present for at least 38 years. The average duration in this series was 8.4 years, as compared with 7 years as reported by McFarland, and 8.75 years by Wood. One-third of our patients presented themselves within a year after first noting the mass; 79 per cent were seen within 5 years.

Rate of Growth.—No fixed growth rate was noted. Twenty-seven of the patients said their tumors grew slowly. Eleven had noticed a lump for many years which suddenly began to grow rapidly. The tumors of the hard and soft palates came to observation an average of 12 months after first being recognized by the patients. This was probably because growth interfered with mastication and deglutition.

Size, Consistency, and Mobility.—Most of the tumors were smaller than 3 cm. in diameter, but some were as large as 12 cm. Larger neoplasms have been reported; McFarland quotes Conterill as having seen a parotid tumor weighing 26 pounds.

On clinical examination, the majority (37) of the neoplasms was firm. However, 8 were described as cystic, 7 as soft, 3 as nodular, and 1 as fluctuant. The primary parotid tumors were freely movable, but the recurrent tumors were adherent to the skin and deeper structures. Twelve of the twenty tumors found in the head outside the large sali-

vary glands were fixed to underlying tissues; the others were freely movable, as were the neoplasms of the submaxillary glands. The single sublingual gland tumor was fixed to the adjacent structures.

Metastasis.—Distant metastasis is recognized as a rare occurrence. In none of the cases in this series was there metastasis to lymph nodes or to distant regions, but a few submaxillary and sublingual mixed tumors with metastasis to the pleura, lungs, and regional nodes have been reported. Erosion of adjacent bone is frequent in cases of tumor of the hard palate, and two patients of this series have had three recurrences, each involving bone.

Diagnosis.—Only 29 of the 56 tumors (43 per cent) were correctly diagnosed before operation. The record was even poorer with the 20 tumors located outside the large salivary glands; only 1 was properly identified clinically. The fact that salivary gland neoplasm is usually not considered in the differential diagnosis of oral tumors probably is responsible. Tuberculous adenitis, branchiogenic cysts, cysts of the parotid, lipoma, sebaceous or mucous cysts, fibroma, and carcinoma were among the clinical diagnoses.

Most diagnostic problems in neoplasia are simplified by biopsy, but the use of this method has not been helpful in this series. Most of these tumors are so small that primary complete surgical removal is not difficult and is to be preferred.

Blady and Hocker, and others, reported radiographic studies on salivary tumors after injection of the ducts with a radiopaque oil. The filling defect in the duct system was said to be of an "orderly nature" in mixed tumors, whereas carcinoma produced an irregular defect which has been described as "puddling."

Treatment.—All of the 56 tumors here reported were excised widely, with the goal of the entire removal of the tumor and its apparently encapsulating tissues. Erich has suggested electrodesiccation of the wound edges in cases of hard palate tumors—a procedure employed in our clinic.

One patient was given x-ray irradiation preoperatively and another postoperatively. Two others were advised to have postoperative x-ray therapy, but failed to reappear for treatment. (Both treated patients have had no recurrences to date.)

Branches of the facial nerve were sacrificed when necessary. A good cosmetic result was considered secondary to complete removal of tumor tissue. Transient facial paralysis was noted in 3 cases. One patient has permanent postoperative paralysis of the mandibular branch of the seventh nerve.

There is no unanimity of choice of therapy in the literature. There is, however, a trend away from the use of x-ray and radium irradiation and toward radical surgical removal of the tumor, including the apparently encapsulating tissues. Ewing advised radical surgery and had little faith in the use of x-rays. Levine has suggested partial excision of

the tumor mass with implantation of radon seeds and radium blocks. Benedict and Meigs, Widmann, Martin and Elkin, and Cohn considered x-ray and radium palliative at best. Fox reported poor results with x-ray. Brunschwig's use of radium and surgery in a case involving the tongue with lymph node metastasis apparently served to check the growth. Thibaudeau and Burke, Malcom, Merritt, and Martin and Elkin wrote of instances in which patients have done well with combined surgical and x-ray treatment.

McFarland reported 300 cases of mixed salivary tumors, and later 413 instances. He thought x-ray of no value and advised complete surgical excision of the tumor and its apparently encapsulating tissues, indicating that this can best be accomplished by allowing the tumor to reach the size of a lemon before operating. This suggestion is obviously useless in dealing with intraoral tumors. Chen and Loucks practiced radical surgical excision of the tumor and all of its capsule, condemning enucleation alone. Kini and Rao, Cohn, and Swinton and Warren all advised primary radical surgery. The latter two authors mentioned persistent salivary fistulas and facial nerve paralysis as troublesome complications. Repair of the facial nerve was suggested by anastomosis of the spinal accessory or hypoglossal nerve to the facial nerve, together with resection of the superior sympathetic chain.

Recurrences.—Nine of the 55 patients in this series did not return to the follow-up clinics. The remaining 46 patients were alive and still under observation in February, 1941; the average postoperative period is 3.8 years. One patient has been observed for less than 3 months, one has been observed over a period of 10 years, and 3 more for over 8 years. Inasmuch as recurrence may take place many years after primary surgical excision (McFarland reports a recurrence 47 years postoperatively), the postoperative period is too short to be certain of cure. Of the 7 patients with tumors which were recurrent upon admission, 5 have been followed with only 1 recurrence since coming under our observation. In this case there is a nodule, 2 by 3 mm., overlying the parotid area. It has not enlarged since it was first noted 1.5 years ago (8 months postoperatively). There have been 4 recurrences (8.4 per cent) in primary cases, making a total of 5 (10.5 per cent) with recurrence since operation at the New York Post-Graduate Hospital. At present there are 3 patients (6.3 per cent) with recurrences, and of these, 2 (4.2 per cent), both with tumors of the hard palate, have active progressive disease. One was unable to foretell which tumors would recur by studying the microscopic anatomy of the primary tumors, a conclusion also reached by McFarland in a recent article. The 2 patients with active recurrent disease were tumors of the hard palate. One was biopsied and the other desiccated before being submitted to surgical excision. These 2 primary tumors showed microscopic features quite similar to others which have not recurred.

At present it is difficult to form any definite conclusions from one's

own observations or from the literature as to why tumors of the salivary gland region recur. However, results lead to the belief that wide regional excision is the only apparent assurance against recurrences.

There is great variation in the percentage of recurrences reported by others. McFarland reports 69 recurrences (23 per cent) among 297 cases, with 13 fatalities. Martin found 34 mixed tumors of the parotid among 65,351 admissions at the Barnard Free Skin and Cancer Hospital, St. Louis, Mo. Of these, 18 submitted to treatment; 10 showed no evidence of recurrence. Thibaudeau and Burke reported 29 cases. Eighteen were symptom-free, 2 improved, 3 recurrent, and 6 dead in a 10-year series. Patey recorded 50 mixed tumors: 38, parotid; 6, submaxillary; 5, hard palate; 1, sublingual. There were 7 recurrences (19 per cent); these included 5 parotid tumors, 1 submaxillary, 1 of hard palate, and the single sublingual neoplasm. One submaxillary case failed to return to the follow-up clinic. Patey believed that the fear of damaging the facial nerve and the failure to remove the encapsulating tissue of the tumor increased the probability of recurrence.

Swinton and Warren had 2 recurrences (4.3 per cent) among 81 cases, of which 9 were classified as malignant. Wide surgical excision was the procedure followed by them. Eggers collected 87 mixed tumors of the hard palate from the literature and added 5 cases of his own; there were only 2 recurrences (2.1 per cent). Sonnenschein called attention to the frequent recurrence of mixed tumors of the soft palate. Chen and Loucks have followed 18 of 38 mixed tumors; they had no recurrences. Nine of the 18 cases had been followed for less than a year.

Prognosis.—It is well known that mixed tumors of salivary gland origin rarely metastasize to distant regions, but they frequently recur locally. Wood reported a tumor that recurred 17 times during 34 years. Statistics compiled over an 11-year period obviously cannot serve as a basis for satisfactory prognosis. Some tumors are quiescent for years. Paller recorded a tumor which was inactive for 37 years, only to increase in size at the end of that time. McFarland reported quiescence for 49 years and Wood for 53 years. It is not unlikely, however, that the probability of recurrence is smaller following radical surgical excision than after any other form of therapy. Those who have followed this course have had, to date, as good or better results than those who utilize combined surgical and x-ray therapy, or x-ray alone.

CONCLUSIONS

1. A series of 56 mixed tumors of salivary structure is reported.
2. Salivary gland tumors outside the large glands are rarely diagnosed correctly.
3. Wide primary surgical excision of the tumor and its apparent capsule is the treatment of choice and the only protection against recurrence.
4. The primary histologic picture does not reveal information which aids in foretelling recurrence.
5. In the series there are 2 patients (4.2 per cent) with active recur-

rent disease; 5 (10.5 per cent) with recurrences since operation, and 4 (8.4 per cent) with recurrences in tumors which were primary upon admission. Of the original 55 patients, 46 (84 per cent) were included in follow-up studies.

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SOME STUDIES WITH ZEPHIRAN

With Particular Reference to Its Use in Time of War

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ZEPHIRAN is a mixture of high molecular alkyl-dimethyl-benzyl ammonium chlorides in which the alkyl group represents a series of homologous radicals derived from the fatty acids of cocoanut oil. It is the purpose of this communication to describe its properties, its applicability in surgery, to report studies which extend its sphere of usefulness and to point out its special utility in surgery in war time.

Zephiran is an amber colored solid of soaplike consistency. It is marketed as a 1:10 concentrate. It is readily soluble in water, alcohol, and acetone. The solution is colorless and almost odorless. It has a definite detergent, keratolytic and emollient action, and is not irritating to skin. It has a low surface tension, 1:1000 aqueous solution having a surface tension of 37.4 dynes per cubic centimeter at 25.3° C.[5] It is procurable and inexpensive. Soap exerts some inactivating influence upon zephiran,[11] but zephiran is compatible with local anesthetic agents, the sulfonamides and other substances with which it may come in contact in operative surgery. It is stable and active over a wide range of temperatures. Freezing, storage at temperatures in excess of 50° C. for eighteen days, and storage at room temperature for more than eight months cause no apparent loss in germicidal efficacy.[4]

Since Domagk[2] described the remarkable bactericidal property of this agent a number of studies have confirmed its value as a germicide.‡[1, 3, 4, 6, 7, 8, 12, 13]

Testing its efficacy against *Staphylococcus aureus, Eberthella typhosa, E. coli, Streptococcus hemolyticus, Str. viridans, Cryptococcus hominis,* and *Monilia albicans* at 37° C., Dunn[4] found its phenol coefficient varied from 274 against *M. albicans* to 579 against *Str. hemolyticus.* The highest dilution which would kill these organisms in ten but not in five minutes varied from 1:25000 against *Staph. aureus* and *M. albicans* to 1:95000 against *Str. hemolyticus.* Comparing the bactericidal activity of phenol, hexylresorcinol, tincture of merthiolate 1:1000, tincture of metaphen 1:200, pepsodent, and aqueous zephiran 1:1000, Dunn[5] found zephiran superior to all the others against *Staph. aureus* both at 20 and 37° C., superior to all of them against *E. coli* at 20° C., and to

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‡We shall not attempt to review the literature completely. A number of articles are not available to us in our present situation.

all except metaphen at 37° C. Comparative studies of the bactericidal action of these agents against *Staph. aureus* in 50 per cent horse serum showed zephiran to be superior to the others. Penetration and inhibition tests carried out by Heineman[6] with the agar cup-plate method demonstrated that zephiran has excellent capacity for penetration and inhibition. *Staph. aureus* was inhibited in a concentration of 1:100,000; *E. typhosa* in a concentration of 1:5000 but not in a concentration of 1:10,000. Miller, Baker, and Harrison[8] found zephiran more active in inhibiting the metabolism of dental bacteria and yeast than fluoride and iodo-acetate. Action of zephiran against the spores of *B. subtilis* is enhanced if the solution is brought to a pH of 8.6.[5]

Zephiran for Preparation of the Hands of Members of the Operating Team.—Since dilute aqueous zephiran has, in our experience, proved so eminently satisfactory for the preparation of the skin of the patient before operation it was felt advisable to investigate its possible use for attempting to sterilize the hands of the operating team. One might suppose that any agent satisfactory for the preoperative preparation of skin might be equally useful in preparing the hands of the members of the operating room staff. This is not necessarily true for two reasons. First, there is a remarkably rapid increase of organisms within the gloved hand increasing with the length of time the gloves are worn.[10] Second, the patient may have greater resistance to the flora of his own skin than to that of others. In addition, however, to remarkable germicidal activity, any solution which might be found useful in this regard would necessarily have to possess two additional attributes, namely, lack of irritation of skin when used repeatedly over long periods of time, and extreme lowness of cost. We know of no other agent which apparently possesses all of these qualities.

Experimental Method.—Two problems had to be solved before the study could be undertaken, first, to devise a method which would give reliable comparative estimates of the worth of various methods of preparing the hands, and second, to make sure that any good results which might be obtained would be due to bactericidal and not to bacteriostatic action. Price[10] has described a method of study giving almost quantitative results and constituting a real advance in the investigation of skin sterilization. This depends upon calculation of the number of organisms present on the skin by scrubbing into a large number of basins for one minute each, doing bacterial counts upon the contents of each basin, and plotting the results, which follow a regular logarithmic curve. Such a method of study could not be employed, however, because in a busy army hospital neither the time nor supplies were available. The method decided upon is the following: The hands were prepared and sterile gloves were put on. After the desired interval of time the cuff of the glove was pulled away from the wrist so that the palmar surface of the hand was visible. Ten cubic centimeters of

sterile normal saline solution were then poured into the glove in such a way as to avoid contact with the cuff of the glove which was contaminated. The fingers of the gloved hand were then extended and flexed so as to mix thoroughly the salt solution with any sweat or epithelial debris which might be present on the palmar surface of the hand, following which several cubic centimeters of the solution were withdrawn by sterile pipette. Exactly 1 c.c. was then plated out in 10 c.c. of dextrose agar. Cultures were read after incubation for forty-eight hours at 37° C. This gave us a roughly semiquantitative method with all factors the same in each instance except the bacterial flora of the hands being tested.

After doing a number of experiments dealing with the inactivation of zephiran by soap, the second problem was finally met by experiments such as are recorded in Tables I and II. In the first experiment

TABLE I

SHOWING THAT ABSENCE OF BACTERIAL GROWTH IN CULTURES OF THE PALMAR SURFACE OF HANDS PREVIOUSLY SOAKED FOR 3 MINUTES IN 1:2500 AQUEOUS ZEPHIRAN AND PLACED IN STERILE RUBBER GLOVES WET WITH THE ZEPHIRAN SOLUTION IS DUE TO DEATH OF ORGANISMS AND NOT TO INHIBITION OF GROWTH BY ANY TRACES OF ZEPHIRAN PRESENT

SOURCE	METHOD OF CULTURE	PLATE NUMBER	NUMBER OF COLONIES
Solution from glove	1 c.c. in 10 c.c. dextrose agar	1	0
	1 c.c. plus 1 drop soap in 10 c.c. dextrose agar	2	0
	1 c.c. plus 2 drops soap in 10 c.c. dextrose agar	3	0
5 c.c. of solution from glove contaminated with 0.1 c.c. of 24 hour old *Staph. aureus* broth culture	1 c.c. in 10 c.c. dextrose agar	4	S. T.*
	1 c.c. plus 1 drop soap in 10 c.c. dextrose agar	5	S. T.*
	1 c.c. plus 2 drops soap in 10 c.c. dextrose agar	6	S. T.*
5 c.c. sterile normal salt solution contaminated with 0.1 c.c. of 24 hour old *Staph. aureus* broth culture	1 c.c. in 10 c.c. dextrose agar	7	S. T.*
	1 c.c. plus 1 drop soap in 10 c.c. dextrose agar	8	S. T.*
	1 c.c. plus 2 drops soap in 10 c.c. dextrose agar	9	S. T.*

*S. T., Several thousand; no significant difference in the number of colonies in plates 4 to 9.

a subject, without other preparation of his hands, soaked them for three minutes in 1:2500 aqueous zephiran and put on sterile gloves wet with zephiran. After thirty minutes 10 c.c. of sterile salt solution were poured onto the palmar surface of his gloved hand according to the method described and as much as possible was removed by sterile pipette. One cubic centimeter of this solution was plated out in dextrose agar, and to two similar plates, one and two drops of liquid green soap were added. Five cubic centimeters of the solution removed from the gloved hand were then inoculated with 0.1 c.c. of a twenty-four hour broth culture of *Staph. aureus* and 1 c.c. portions of this contaminated solution were similarly plated. Five cubic centimeters of sterile normal

TABLE II

SHOWING THAT ABSENCE OF BACTERIAL GROWTH IN CULTURES OF THE PALMAR SURFACE OF HANDS PREVIOUSLY SOAKED FOR 3 MINUTES IN 1:1000 AQUEOUS ZEPHIRAN AND PLACED IN STERILE RUBBER GLOVES WET WITH THE ZEPHIRAN SOLUTION IS DUE TO DEATH OF ORGANISMS AND NOT TO INHIBITION OF GROWTH BY ANY TRACES OF ZEPHIRAN PRESENT

SOURCE	METHOD OF CULTURE	PLATE NUMBER	NUMBER OF COLONIES
Solution from glove	1 c.c. in 10 c.c. dextrose agar	1	0
5 c.c. of solution from glove contaminated with 0.1 c.c. of 24 hour old broth culture of *Staph. albus*	1 c.c. in 10 c.c. dextrose agar	2	4000-6000*
5 c.c. of sterile normal salt solution contaminated with 0.1 c.c. of 24 hour old broth culture of *Staph. albus*	1 c.c. in 10 c.c. dextrose agar	3	4000-6000*

*Counting under magnification of a small measured area revealed no significant difference in the number of colonies in plates 2 and 3.

salt solution were then contaminated with 0.1 c.c. of the same broth culture, and 1 c.c. portions of this were plated in similar fashion. After forty-eight hours there was no growth in the first three plates. Several thousand colonies were present in the remaining six plates. Although the colonies were too numerous for accurate count, counting of a small measured portion of each plate under magnification revealed no significant difference in the number of colonies in these six plates. This experiment demonstrated that the maximal amount of zephiran which might be present on the palmar surface of the hands on which 1:2500 zephiran had been used was insufficient to cause any inhibition of growth once it had been diluted with the standard amount of salt solution and agar. A second experiment carried out in the same manner gave identical results. In the experiment recorded in Table II similar studies were made after soaking the hands in 1:1000 aqueous zephiran and putting on gloves wet with the zephiran solution. This experiment also showed that not enough zephiran was present to cause any inhibition of growth in the culture plates.

The studies were all carried out in the operating room, usually in the midafternoon. The room temperature could not be kept constant but varied little from day to day, averaging 85° F. Subjects were officers, nurses, and enlisted men of the operating room staff. Before the experiments were begun the subjects had been performing their regular duties, such as oiling instruments, sorting dirty linen, scrubbing the floor. The hands were not washed and the nails were not cleaned before the experiments were begun. After preparation of the hands the subjects put on sterile rubber gloves and then resumed their regular duties, no effort being made to keep the outside of the gloves sterile. Gowns were not worn. In two instances a glove was inadvertently torn so that culture from this hand could not be obtained. Ordinarily six subjects were used, a culture being obtained from the left hand after having the gloves

on for one-half hour and from the right hand after one hour.

The results obtained are recorded in Table III. Two subjects whose hands were grossly clean but had not been prepared in any manner put on sterile gloves, and cultures were obtained after thirty and sixty minutes. There was considerable variation in the number of colonies present in cultures of the hands of the two individuals. There was an average of more than 120 colonies after thirty minutes and more than 300 after one hour. Six subjects scrubbed their hands and forearms vigorously with liquid green soap and running tap water for three minutes using sterile brushes, then carefully cleaned their nails, scrubbed with soap and water for an additional five minutes and then soaked their hands and forearms for three minutes in 70 per cent by weight ethyl alcohol. After thirty minutes none of the twelve hands cultured showed any growth of organisms, but after one hour 42 per cent of the hands cultured showed some growth, the average number of colonies in those plates showing growth being 1.4 per plate.

Without any cleansing of the hands or nails twelve subjects soaked their hands for three minutes in 1:2500 aqueous zephiran, washing the hands with a wash cloth as they soaked. Following this, sterile gloves were put on wet with zephiran, the hands being held up to allow all of the solution possible to drain out of the gloves. After the gloves were on for one-half hour 42 per cent of the cultures showed some growth, the average number of colonies being 3.2; after one hour 42 per cent also showed some growth, the average number of colonies being 1.6. Twelve subjects similarly prepared their hands by soaking for three minutes in 1:2500 aqueous zephiran after which they dried their hands and put on dry sterile gloves. After one-half hour 25 per cent showed some growth, the average number of colonies being 2, and after one hour 25 per cent showed some growth of organisms, the average number of colonies being 1.3. The slightly higher incidence of positive cultures with the wet technique may have possibly been due to the fact that certain subjects may have inadvertently lowered their gloved hands while their unsterile forearms were still wet with the solution which had drained down from within the glove, thus carrying back into the glove some organisms. Twelve subjects scrubbed their hands with 1:2500 aqueous zephiran and tap water for three minutes, following which the hands were soaked in 1:2500 zephiran for three minutes. There was only one colony which grew out in the plates from twenty-three hands cultured.

Similar experiments were carried out with 1:1000 aqueous zephiran. After a three minute soak, gloves were put on by the wet technique. Only one hand cultured showed any growth of organisms and in this instance only a single colony. After hands were soaked for three minutes and dry gloves put on, two hands showed a growth of a single colony in thirty minutes and one after one hour. Twelve subjects

TABLE III

THE RESULTS OBTAINED FROM CULTURE OF HANDS PREPARED IN VARIOUS WAYS

TECHNIQUE	GLOVES KEPT ON FOR 30 MIN.			GLOVES KEPT ON FOR 60 MIN.			TOTAL		
	NO. HANDS CULTURED	PER CENT SHOWING GROWTH IN CULTURE	AVERAGE NO. COLONIES IN THOSE SHOWING GROWTH	NO. HANDS CULTURED	PER CENT SHOWING GROWTH IN CULTURE	AVERAGE NO. COLONIES IN THOSE SHOWING GROWTH	NO. HANDS CULTURED	PER CENT SHOWING GROWTH IN CULTURE	AVERAGE NO. COLONIES IN THOSE SHOWING GROWTH
No preparation	2	100	120	2	100	300	4	100	210
Soap & water scrub for 8 min., alcohol soak 3 min., gloves dry	12	0	0	12	42	1.4	24	21	1.4
Zephiran 1:2500, soak 3 min., gloves wet	12	42	3.2	12	42	1.6			
Zephiran 1:2500, scrub 3 min., gloves dry	12	25	2.0	12	25	1.3	71	24	2.0
Zephiran 1:2500, scrub 3 min., soak 3 min., gloves dry	12	8	1.0	11	0	0			
Zephiran 1:1000, soak 3 min., gloves wet	12	0	0	12	8	1.0			
Zephiran 1:1000, soak 3 min., gloves dry	12	17	1.0	12	8	1.0	71	7	1.0
Zephiran 1:1000, scrub 3 min., soak 3 min., gloves dry	12	0	0	11	9	1.0			

scrubbed their hands for three minutes in a basin containing 1:1000 zephiran, all scrubbing into the same small basin and using no running water at all, after which the hands were soaked for three minutes in 1:1000 zephiran. Only one hand showed any growth of organisms, this being a single colony.

It is not felt that the absence of growth of organisms in cultures from the gloved hands of our subjects indicates that the hands were sterile. It appears that absolute sterility of the skin of hands and forearms is impossible to attain.[10] It is felt, however, that the method employed is a valid comparison of the effectiveness of the various methods used in these experiments in rendering the hands as free of organisms as is possible. The method of culture was the same in all instances and that portion of the gloved hands cultured is the one in which sweating is most abundant.

It is apparent that there were fewer hands from which positive cultures were obtained after brief scrubbing with 1:2500 zephiran and a short soak in this solution, and after simply soaking the uncleansed hands in 1:1000 zephiran for three minutes than there were after the most rigorous scrubbing with liquid green soap for eight minutes followed by soaking in 70 per cent alcohol for three minutes. Twenty-one per cent of the hands prepared by the usual soap and water and alcohol technique showed some growth of organisms. Of seventy-one hands prepared with 1:2500 aqueous zephiran, 24 per cent showed growth of some organisms. Of seventy-one hands prepared with 1:1000 zephiran, only 7 per cent showed growth of organisms, only one colony growing out in each instance. It would appear that one could at least conclude from this that a brief soak in 1:1000 zephiran brings about as good a preparation of the hands as the most rigorous soap and water scrubbing followed by soaking in alcohol. Certainly this would appear to be particularly true if the soak in zephiran is preceded by a brief scrubbing in this solution.

After soaking in zephiran the hand has a very comfortable satiny feel which persists for several hours. Zephiran cleans the hands very well. It is more effective in removing oil and greasy debris than is soap and water. Used day after day over a long period of time it never causes any skin irritation and does not make the nails brittle or discolored.

It is our feeling that preparation of the skin of the hands and forearms of members of the operating team can be reliably carried out as follows: Clean the nails, scrub the hands and forearms vigorously in aqueous zephiran 1:1000 for three minutes, and soak them for three minutes in a basin containing this solution. Between clean cases soak the hands in zephiran for three minutes. Scrubbing with 1:1000 aqueous zephiran causes no real lather but a lather is obtained when one scrubs with 1:500 zephiran and this dilution may be employed for

scrubbing if it is desired. If the hands are moistened with zephiran they can be easily slipped into powdered, dry sterilized gloves. Most of those who have put on gloves in this manner feel that their hands are more comfortable than when they are put on dry with talcum powder. Although we have no objective proof it would seem likely that the film of zephiran on the hands would tend to inhibit growth of those organisms which may remain on the skin.

Zephiran in the Preparation of the Operative Field.—Zephiran has been used by a number of individuals in the preparation of the patient's skin before operation, but ordinarily in combination with some other antiseptic agent. Walter[12] reports that 2000 patients have undergone operation at the Peter Bent Brigham Hospital, with the operator using three changes of 1:1000 aqueous zephiran alternating with three changes of 70 per cent alcohol. He did not cite the incidence of wound infections. In 75 cases a biopsy was taken of the skin prepared in this manner from which cultures were made after maceration of the tissue. Seventy-three per cent showed no growth of organisms. White, Collins, and Newman[13] used a skin preparation of soap and water, benzine, alcohol, and tincture of zephiran, 1:1000. In fifty-one operative cases there was a single wound infection while there were seven wound infections (28 per cent) in twenty-five cases in which 3.5 per cent tincture of iodine was used in preparation of the skin. Biopsies of the skin taken before and after this clean up in fifty-one cases were cultured. In every instance there were organisms from the biopsy taken before skin preparation, in only two instances from biopsies taken after skin preparation.

Wright and Wilkinson[14] found zephiran very useful in traumatic surgery. One of us (H. B. S., Jr.) began to use zephiran for skin preparation in 1937, at which time he was a member of the surgical staff of the New Haven Hospital. The routine skin preparation in this hospital consisted of soap and water, alcohol, and 1:2000 aqueous zephiran. With this technique, in the year 1937-1938 the incidence of wound infection was as low as during any preceding year in which other germicidal agents had been used, the incidence in clean cases being 2.4 per cent including all stitch abscesses and other trivial infections as well as the more obvious wound infections.

In the 118th General Hospital the routine skin preparation before operation on the surgical service has consisted in sponging off the operative field with three or four changes of 1:2500 aqueous zephiran. Preceding this, the area has been shaved either dry or after simply wetting the area with aqueous zephiran. All members of the staff have been pleased with this routine. The incidence of stitch abscesses is not known but we have the impression that it is very low. There were three obvious wound infections in the first 350 clean cases thus prepared. One of these was a subcutaneous abscess under the donor area from

which pinch grafts were removed to be placed upon an infected granulating area. It appears that the donor site must have been contaminated by some faulty technique from the infected recipient area, or that the needle or procaine solution was contaminated. The second case was that of a superficial wound infection following repair of a ventral postoperative hernia which was carried out eleven weeks after exploration for multiple perforations of the bowel and only five weeks after a partially disrupted wound had healed. The third instance was that of an unexplained mild wound infection after inguinal herniorrhaphy. In none of these instances was sulfanilamide powder used. In a rather large number of the cases included in this group sulfanilamide powder in small amounts was implanted in the wound.

These data are not given as proof of the superiority of zephiran for preparation of the skin. In those reports mentioned other germicidal agents were used in conjunction with zephiran. In our own cases sulfanilamide powder was used locally in many wounds. Even if a series of cases was presented eliminating such factors, it would not necessarily furnish any conclusive evidence that the zephiran was responsible for the low incidence of wound infections. Many things must be considered in such an evaluation. Wound infections will be fewer when the surgical technique is gentle, when absolute hemostasis is achieved, when mass ligatures and strangulation of tissue are avoided, when small suture material is used, and when a rigid aseptic technique is maintained. In addition, there are two sources of organisms which may contaminate wounds other than the patient's skin, namely, the air of the operating room and the hands of the operator and his assistants. Indeed, there is much to suggest that the hands of the operating team may be more frequently the source of organisms causing wound infection than either the patient's skin or the air of the operating room. Gloves are punctured in a surprisingly large number of cases and a punctured glove may be responsible for thousands of organisms entering the wound. It is felt, however, that the data given do indicate that zephiran is a perfectly adequate agent for skin preparation. Furthermore, in vitro studies demonstrate it to have greater germicidal efficacy than most of the antiseptics commonly employed for this purpose. In addition, its cheapness commends it. It has other very distinct advantages for the preparation of skin.

It is easily applied and cleanses the skin well since it has a certain detergent and keratolytic action. It has not been necessary to use with it any other cleansing agent. In numerous instances when patients have been brought in after traumatic lacerations received on the streets, areas covered with grease and dirt have been cleaned without difficulty. Should the situation arise where it is felt that grease is being inadequately removed one might supplement the zephiran clean-up by sponging the area with ether. The solution is nonirritating to skin. From

a rather large personal experience and the reports of the literature examined, we know of no instance in which there has occurred dermatitis, burn, or any skin irritation due to the use of aqueous zephiran. In the dilute solutions which are employed it causes no reaction if it is allowed to run into the various body orifices and cavities. It has a great advantage in the preparation of the face where it can be allowed to run into the external auditory canal, eyes, nose, and the mouth without fear of tissue damage. One has no concern about the various body creases and folds as one does with so many of the antiseptics employed for skin preparation. One particular advantage of dilute aqueous zephiran is that it can be used freely in open wounds with apparently no deleterious tissue reaction. Walter[12] and Deskowitz[1] injected 1:1000 aqueous zephiran into the peritoneal cavities of guinea pigs daily for a long period of time and found that the solution caused no reaction, although more concentrated solutions did cause some fibrinous reaction. We have poured the solution freely into open wounds both in traumatic cases and in elective operations and have never noticed any tissue reaction or any retardation of healing. This is a marked contrast to the severe tissue damage which is caused by alcohol, iodine, and many other agents which are used in skin preparation. In traumatic lacerations the task of preparing the area about the wound is immensely simplified when one can permit the solution to run into the laceration.

If there is difficulty in preparing a hand or foot it may be useful to scrub the part with a brush wet with zephiran and soak it in a basin of this solution. For those who prefer to prepare the operative field some hours beforehand as well as immediately before operation, the area may be prepared with zephiran and covered with a wet zephiran dressing some hours before the patient is brought to the operating room and prepared again in the usual manner immediately before draping the patient. For most general surgical procedures there is no disadvantage and possibly some advantage in using a colorless solution, but where a large area must be prepared as, for example, in certain orthopedic operations it may be preferable to add to the zephiran solution some dye to impart color to the skin with which it comes in contact.

Although we have found 1:2500 aqueous zephiran to be satisfactory for the preparation of skin we are now using a 1:1000 solution since in vitro studies demonstrate that the 1:1000 solution kills organisms much more quickly than does the 1:2500. This is illustrated by the experiment described in Table IV. Twenty-one hemostats were immersed in a broth culture containing a luxuriant growth of *Staph. aureus, Str. hemolyticus, B. proteus, E. coli,* and *Clostridium tetani.* They were then placed upon a sterile field in order to dry and to allow the organisms to become fixed. Six of the clamps were then immersed for varying lengths of time in 1:2500 zephiran, another six in 1:1000 zephiran, and another six in an instrument-sterilization solution containing formalin

TABLE IV

EFFECTIVENESS OF 1:2500 AND 1:1000 AQUEOUS ZEPHIRAN IN THE STERILIZATION OF INSTRUMENTS

SOLUTION USED	ORGANISMS PRESENT AFTER SOAKING CONTAMINATED INSTRUMENT IN GERMICIDAL SOLUTION FOR VARYING LENGTHS OF TIME					
	1 MIN.	5 MIN.	10 MIN.	15 MIN.	20 MIN.	30 MIN.
Zephiran 1:2500	Gram–rods Gram+rods Gram+cocci Heavy	Gram–rods Gram+cocci Moderate	Gram–rods Gram+cocci Moderate	Rare Gram+rod Gram+cocci	Sterile	Sterile
Zephiran 1:1000	Moderate Gram–rods Rare Gram+cocci	Sterile	Sterile	Sterile	Sterile	Sterile
Instrument—sterilizing fluid	Sterile	Sterile	Sterile	Sterile	Sterile	Sterile
Control A:	Gram+cocci Gram–rods Gram+rods (rare) Heavy	Control B:	Gram+cocci Gram–rods Gram+rods Heavy	Control C:	Gram+cocci Gram–rods Gram+rods Heavy	

Control A: Instrument contaminated, allowed to dry and placed in culture medium. Control for viability of organisms.

Control B: Instrument contaminated, dried, placed in 1:1000 zephiran, washed, recontaminated, and cultured. Control for possible inhibition by traces of zephiran on instrument.

Control C: Instrument contaminated, dried, placed in instrument-sterilizing fluid, washed, recontaminated, and cultured. Control for possible inhibition by traces of instrument-sterilizing fluid on instrument.

which had been prepared in this hospital by Major W. B. Vandegrift for the cold sterilization of instruments. Following immersion in the various solutions each clamp was momentarily rinsed with sterile saline solution in order to remove traces of the germicidal agent and was then placed in a test tube containing Brewer's thioglycollate medium and incubated at 37° C. for twenty-four hours. The clamps were left in the medium for fourteen hours. One clamp was not immersed in any antiseptic solution but was placed in Brewer's thioglycollate medium as a control for the viability of the organisms. All of the organisms multiplied in large numbers (Control A). A second clamp was used as a control for the instrument-sterilizing solution, the clamp being recontaminated with organisms after it had been placed in the solution and had been rinsed with salt solution in the usual manner. All of the organisms grew readily, demonstrating that with the technique employed any traces of the germicidal agent present were insufficient to inhibit growth (Control C). A similar test with 1:1000 zephiran also showed that there was not enough zephiran present to inhibit growth of organisms (Control B). There was no growth from any of the contaminated clamps which had been placed in the instrument-sterilizing solution even after only one minute in the solution. There was a moderate growth of gram-negative rods and a rare gram-positive coccus from the contaminated clamp which had been in contact with 1:1000

zephiran for one minute, but there was no growth whatsoever from the clamps which had been in the solution for five minutes or more. There was some slight growth of organisms from the clamp which had been in contact with 1:2500 zephiran for fifteen minutes. It is not felt that this experiment forms a sufficient basis to permit any positive conclusion in regard to the utility of aqueous zephiran for the cold sterilization of instruments but it suggests that solutions as dilute as 1:1000 may be fairly satisfactory for this purpose. Of course if aqueous zephiran or any other aqueous solution is used for the cold sterilization of instruments it is necessary to add some substance to prevent rusting. It is our feeling that formalin solutions of the type marketed by Bard-Parker Company, Inc., are so eminently satisfactory for cold sterilization of instruments that solutions of this sort should preferably be used for this purpose.

Other Uses of Zephiran.—Dilute aqueous zephiran (1:1000 or 1:2500) has a number of other uses. It is ideal for washing instruments and the hands of the operating team during the course of an operation. Whereas 76 per cent of basins of sterile water so used were found to be contaminated at the close of the operation, Poppe[9] found that basins of 1:5000 aqueous zephiran were always sterile. Similarly, aqueous zephiran is useful for wash basins necessary in maintenance of isolation technique for cases of infectious disease. It is perfectly satisfactory for cleansing skin before venipunctures and various parenteral injections. Where instruments on dressing carriages are kept in some irritating sterilizing fluid, it is useful to keep alongside a jar of aqueous zephiran in which the instruments can be rinsed before being used. It is useful in compresses and soaks for various pyogenic skin lesions, and for epidermophytosis, particularly when it is associated with secondary infection. It is occasionally useful as a compress in clearing up infections of granulating areas. It works well as an irrigating solution for empyema and other abscess cavities. As a 1:20,000 solution it is satisfactory for urethral instillations. More concentrated solutions cause irritation. The possibilities of its use as instillations in the conjunctival sac for conjunctivitis and in preparation for ophthalmologic operations are under investigation in association with Capt. F. M. Reese. Instillations and tampons of 1:2500 zephiran have proved useful in treating various pyogenic and fungus infections of the external auditory canal. Zephiran in concentration of 1:50,000 has been found ideal for the preservation of biologic fluids such as bacteriophage and vaccines.[7]

The Use of Zephiran in Time of War.—In time of war certain considerations assume a significance which is not existant in time of peace, such as the conservation of materials which are vital in the making of munitions and military supplies. Such a substance is alcohol, of which enormous quantities are ordinarily employed in the practice of

medicine. It is used alone or in combination with other germicidal agents by the vast majority of physicians for the preparation of the patient's skin before operation, as a soak for hands after scrubbing, in preparing skin before venipuncture and various parenteral injections, for cleaning the skin when dressings are changed, and for many other purposes. For none of the purposes mentioned is it really necessary, and it is felt that by more extensive use of substances such as zephiran great quantities of alcohol can be conserved for purposes which are immediately more vital than these medical uses. Aqueous zephiran is a better germicidal agent and is more stable. It must be remembered that, although 70 per cent ethyl alcohol by weight is a good germicide, it is difficult to maintain this exact concentration, and that even slight changes in concentration render the solution totally ineffective against organisms.[10]

In regard to the medical services of the armed forces, certain other considerations arise. Scattered as the various medical installations are over the surface of the globe, transportation of medical supplies assumes gigantic proportions. If a substance can be transported in small volume which will do equally well the work that far greater volumes of some other agent will accomplish, there are obvious advantages in utilizing the former. If 1:2500 zephiran is employed, 250 gallons are available for use from each gallon of the concentrate transported to the medical unit. If 1:1000 zephiran is used 100 gallons are available for use from each gallon transported. Furthermore, it is entirely possible that should the armed forces desire to employ this agent in any considerable quantity, the manufacturers could supply the solid zephiran rather than the 1:10 concentrate, which would multiply again by ten the amount of solution available for use from each unit of material transported. Another feature which is desirable in the various medical installations is a simplification of the pharmaceutical armamentarium. Zephiran can be utilized so effectively in place of alcohol and the numbers of other germicidal agents which are ordinarily supplied, that it would seem worth while to substitute it for others. These considerations are particularly applicable in the forward medical installations such as the portable hospitals and the clearing companies of the medical battalions. It is our feeling that such units could perform a good service without any real handicap if they were supplied with adequate amounts of zephiran alone and no other bactericidal agents except for what alcohol is needed for the preparation of certain tinctures which may be advisable and except for a small amount of some formalin instrument-sterilization solution. A further consideration is that of expense, which remains important even at a time when Federal expenditures are necessarily gigantic. In the base from which this paper is written, zephiran, which is made in the United States and transported thousands of miles as a 1:10 concentrate, can be purchased at such a price that

1:1000 aqueous zephiran costs only approximately 13 cents per gallon, 1:2500 zephiran only about 5 cents per gallon. In contrast, the ingredients which are used in the preparation of liquid green soap bring the cost of this substance to about 25 cents a gallon, and the cost of alcohol is approximately 32 cents a gallon. Needless to say, many of the germicidal agents employed are a great deal more expensive. Another consideration which is of special importance is that of the preparation of the hands of the members of operating teams which can be carried out adequately with aqueous zephiran in any forward medical installation.

SUMMARY AND CONCLUSIONS

Zephiran is a cheap and reliable germicidal agent. In dilute solution it has been found to serve very satisfactorily for multiple purposes in hospital and medical practice and its sphere of usefulness appears to be steadily increasing. It serves ideally as an agent for preparing the skin of patients before operation. It has many advantages over some of the more commonly employed germicidal agents: cheapness and procurability, well proved high and nonspecific germicidal activity, failure to cause burns, dermatitis, or other irritation of skin and mucus membranes, ease of application. Studies indicate that a brief scrubbing of the hands and forearms in 1:1000 aqueous zephiran followed by a three-minute soak in this solution achieves, with ease, as thorough cleansing as prolonged scrubbing, in situations where facilities for proper scrubbing according to the generally used soap-and-water technique are not available. Since zephiran is used in dilute solution, large amounts are available for use from a relatively small amount of the concentrate or solid transported to any given point. Its use results in a conservation of alcohol which is essential for vital war products. Because of these considerations it is felt that a widespread use of this reliable agent is particularly desirable in time of war.

The authors wish to express their appreciation to Major Paul Kunkel who suggested that zephiran might prove of value in the preparation of hands, to Dr. Samuel C. Harvey for permission to cite statistics from the New Haven Hospital, and to 2nd Lt. Anne H. Seeney and the members of the operating room staff for their cooperation in carrying out the experiments.

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Book Reviews

Renal Lithiasis. By Charles C. Higgins. Pp. 140, with 18 illustrations. Springfield, Ill., 1943. Charles C Thomas.

This is a collection of Beaumont lectures. Considering its small size, it is a remarkably thorough discussion of renal lithiasis, and particularly of those factors which lead to the production of stones composed of phosphates and carbonates, although there is some discussion of other types. It seems to the reviewer that there is a little too much emphasis upon the role of deficiency of vitamin A in the diet, upon the reaction of the urine, and upon infection, since there are many cases in which these factors cannot be shown to have operated. The mechanism of formation of oxalate stones is not explained (I am not sure that anyone *can* explain it yet), and it is unfortunate that a book on lithiasis for the medical profession in general makes no mention of the importance of bone injury with prolonged recumbency as a factor in lithiasis, since this is one situation in which the formation of stones can probably be prevented by the alert physician.

It is questionable whether anyone besides the author has succeeded, or will succeed, in dissolving any considerable number of renal calculi by dietary regulation alone.

However, the book is of great value to all who are interested in urinary lithiasis, and should be read with care. It contains a map delineating stone areas, discussions of operative technique, and detailed tables of various diets intended for the dissolution or prevention of calculi of different types. There is a valuable bibliography.

The author also describes chemical methods for the recognition of the various constituents in stones. These are said to be far more accurate than those in general use.

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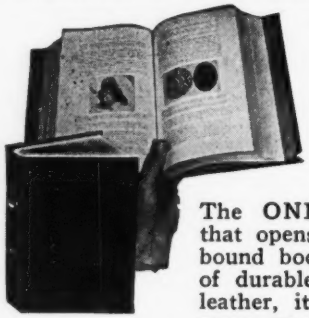

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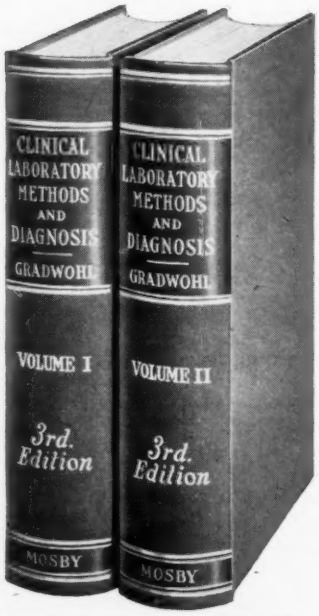

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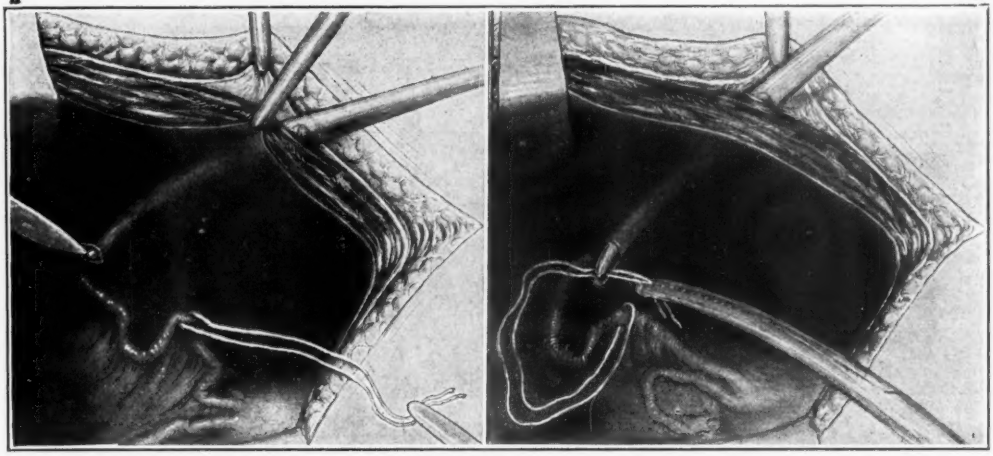

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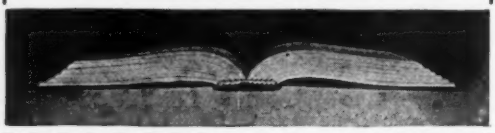

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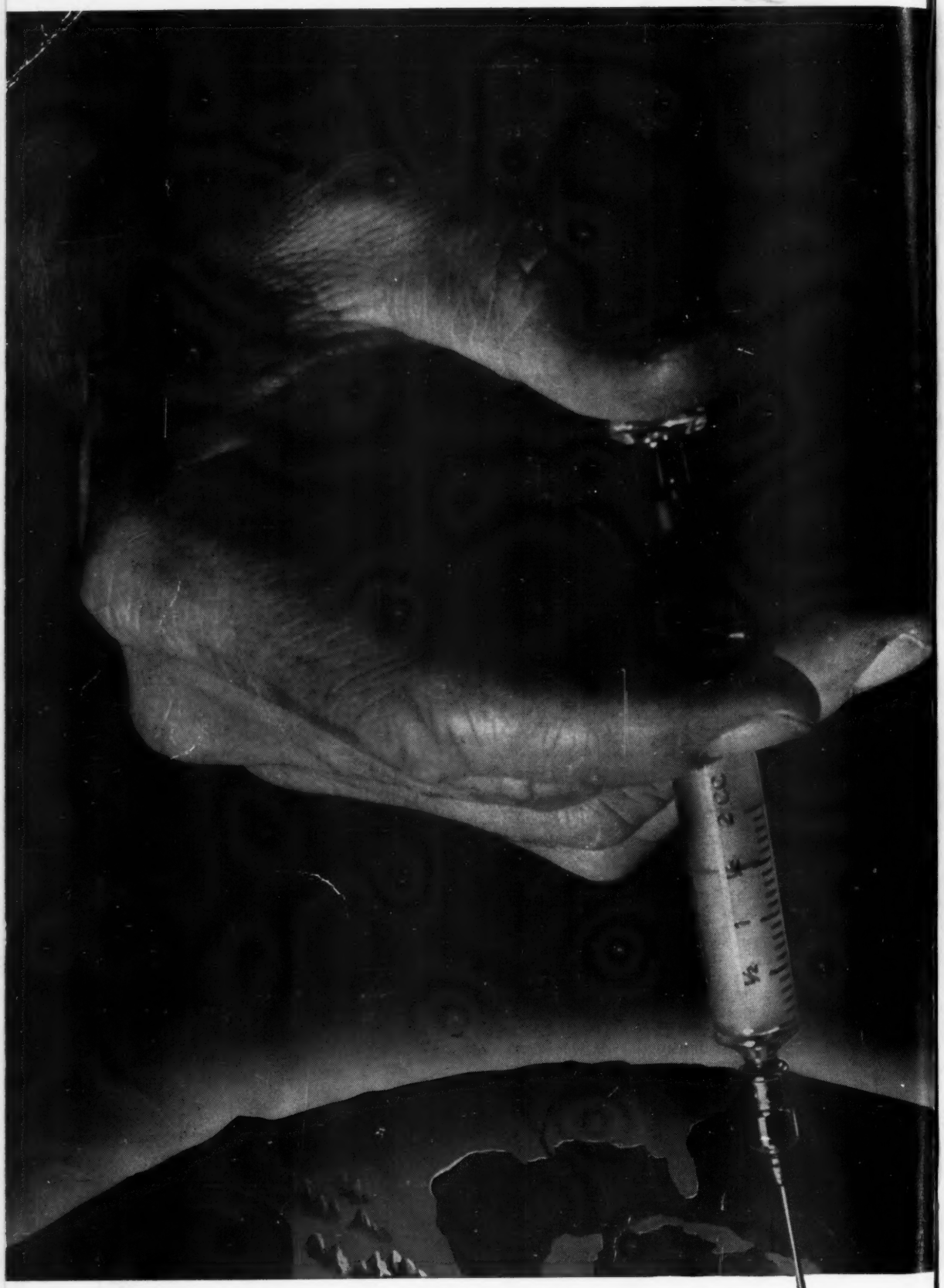

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